Digital Equipment Corporation
Maynard, Massachusetts

digital

Maintenance Manual

LA30
DECwriter

DEC-00-LA30-DC

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LA30 DECwriter
MAINTENANCE MANUAL

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LA30 DECwriter

CHAPTER 1
INTRODUCTION

1.1 SCOPE

This manual contains general information, installation, operating, technical reference, and maintenance data for the LA30 DECwriter manufactured by Digital Equipment Corporation (DEC), Maynard, Massachusetts. In addition, Appendix A provides an illustrated parts breakdown and associated parts list for the LA30 base and printer mechanism assemblies.

1.2 GENERAL DESCRIPTION

The LA30 DECwriter is a dot matrix impact printer and keyboard for use as a hard copy I/O terminal. The unit can be interfaced with all DEC PDP Product Lines, having been designed to replace the standard Teletype® Model 33, 35, and 37 KSR.

The LA30 DECwriter is capable of printing a set of 64 ASCII characters at a speed of up to 30 characters/second on a sprocket-fed 9-7/8 in. wide continuous form. Data entry is made from a keyboard capable of generating either 97 or 128 characters.

Mechanically, the LA30 is an extremely simple device, providing a reliable terminal that is relatively maintenance free. The LA30 incorporates a print mechanism, a keyboard, and associated logic and power supply, complete with operating stand and interconnecting cables. Jumpers can be field-installed for 100, 110, 120, 220, or 240 Vac, 50- or 60-Hz. Line cord plug must be selected.

1.3 TECHNICAL CHARACTERISTICS

Table 1-1 is a complete listing of the LA30 DECwriter specifications.

Table 1-1
LA30 DECwriter Specifications

Specification	Description
Printing Speed	30 characters/second, asynchronous. 30 line feeds/second, 300 ms carriage return
Line Length	80 character positions
Character Spacing	10 characters/in.
Line Spacing	6 lines/in.

(continued on next page)

® Teletype is a registered trademark of Teletype Corporation.

Table 1-1 (Cont)
LA30 DECwriter Specifications

Specification	Description
Paper	9-7/8 in. wide continuous form, tractor driven. (1/2 in. pitch X 9-3/8 in. wide X 0.150 in. diameter feed holes)
Copies	One part: 12 to 20 lb paper Two part: 12 to 13 lb paper 7 to 7-1/2 lb carbon
Ribbon	4 mil Nylon, 1/2-in. X 120 ft, medium inking
Typeface	5 X 7 dot matrix
Printing Characters	64 upper case ASCII subset (lower case codes print in upper case)
Keyboard Characters	97 or 128 (switch selectable)
Code	USASCII – 1968
Interface	Available for all DEC Computers. TTL-compatible, parallel (17 pairs plus 1 spare pair in cable). Interface is ASCII encoded. The Serial Interface is an extra cost option. Switch selectable 110, 150, or 300 baud. Four-wire 20 mA current loop interface compatible with all DEC computers or EIA RS232C.
Temperature	50°F (10°C) – 122°F (50°C)
Humidity	5 – 90% (non-condensing)
Dimensions	
Depth Width Height	24 in. (0.61m) 20-1/2 in. (0.5m) 31 in. (0.79m)
Weight	110 lb (50 kg)
DC Power Supply	Self-contained (DEC Type H735)
Power Input	115/230 Vac ± 10% 50/60 Hz 300W, maximum

CHAPTER 2
INSTALLATION

This chapter outlines LA30 unpacking and inspection procedures, installation, cable connections, and unit check-out. A brief discussion of LA30 site considerations is also provided.

2.1 SITE CONSIDERATIONS

The LA30 DECwriter should be located in an area free of excessive dust and dirt or corrosive fumes and vapors. To ensure proper cooling, the ventilation openings on the sides of the control box assembly must have no obstructions within 4 in., and the perforated bottom of the control box must have no obstruction within 1/2 in. Adequate clearance must be provided for servicing the machine. The applicable cabinet dimensions are shown in Figure 2-1. Temperature and humidity specifications are included in Table 1-1.

2.2 UNPACKING AND INSPECTION

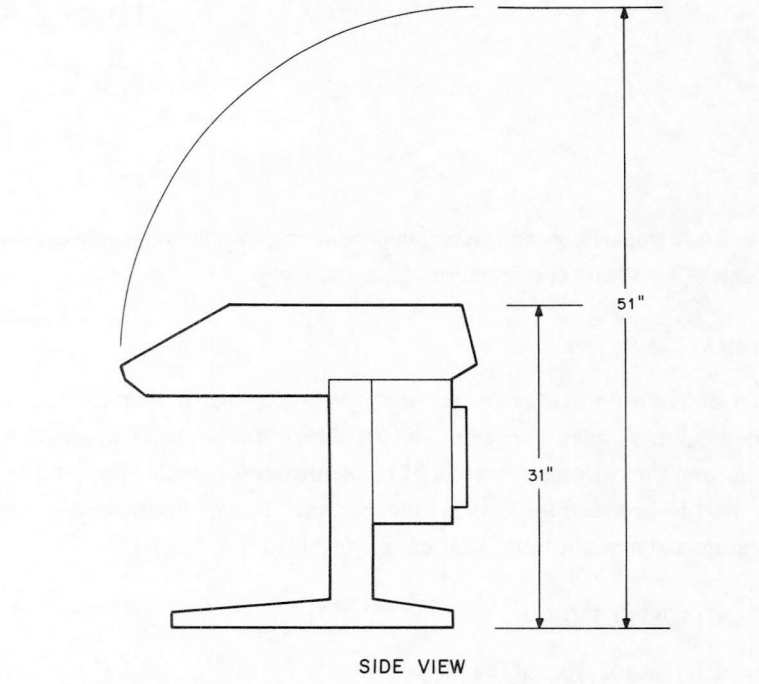
To unpack and inspect the LA30, proceed as follows:

1. Remove the outer shipping container by first removing any metal straps, fasteners, and/or cleats securing the carton to the skid.
2. Remove any shock absorbing packing materials from the unit. Remove the hold-down tape on the cover and on both ribbon reels. Remove the shipping clamp from the drive belt.
3. Inspect external surfaces for possible shipping damage. Report any damage to the local DEC Field Service Office.
4. Make certain that the cover hinge and fasteners are intact.
5. If the cover seems to have dislodged in shipping, check the flanges on the timing belt pulleys for dents, and check the ribbon drive motors for bent shafts.
6. Check the four Allen Head shoulder bolts that secure the printer mechanism to the base for tightness.
7. Make certain that the cam lever securely clamps the print bar casting to the carriage support casting.
8. Check to see that the keyboard bezel has not shifted (should not bind keys).
9. Check that the 12 push-on connectors on the microswitches, part of the signal cabling, are properly seated.
10. Inspect the interior of the cabinet for possible damage to cables, loose or broken modules, or cracks in the cover.
11. Inspect the wiring side of the logic module mounting panel for bent pins, cut wires, broken bus, loose external components, and foreign material. Any defects should be corrected by DEC Field Service personnel.

(continued on next page)

12. Inspect the power supply for proper seating of power connectors.

13. Remove the bolts securing the stand to the shipping skid, replace them with the four rubber feet supplied, and locate the DECwriter near its operating position.



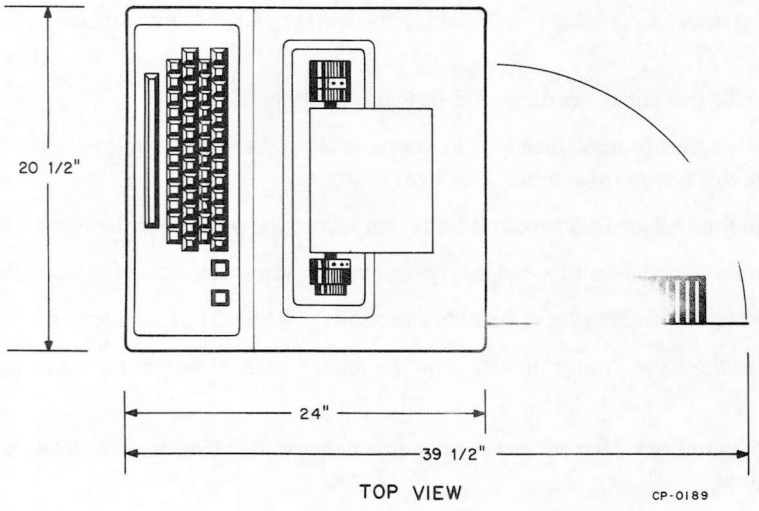


Figure 2-1 LA30 Installation Dimensions

2.3 LA30 INSTALLATION

The DECwriter is equipped with leveling feet. It is not necessary to bolt it to the floor unless conditions dictate otherwise (e.g., shipboard installation). To install the LA30, proceed as follows:

1. Locate the DECwriter at its final operating position.
2. Adjust the leveling feet on the stand until the unit is plumb.
3. If necessary, clean all outer surfaces with a clean, soft, lint-free cloth.

2.4 CABLE CONNECTIONS

2.4.1 Power Cable

The power cable, already secured to the power supply, should be removed from its storage position in the control box assembly, fed through the opening in the bottom of the control box, secured by the cable clamp on the inside of the right leg, and connected to the switched power outlet on the system processor.

CAUTION

Before connecting the LA30 to local power, be certain that line voltage and frequency are compatible with power requirements (Table 1-2). Also make certain that the double circuit breaker on the rear of the control box assembly is in the OFF (down) position.

2.4.2 Interface Cable

To install the LA30 parallel interface cable, the cover of the control box assembly must be removed. At the rear of the cabinet, remove and set aside the rear cover by turning the captive thumb screw. Turn the captive thumb screw on the right-hand side of the logic panel and swing the panel out on its hinges. The cable interconnects between A06 on the logic panel and the interface module of the system in which the LA30 is to operate (see site plan). Secure this cable by the cable clamp on the inside of the right leg, after feeding it through the hole in the bottom of the control box. The serial interface cable is installed in the same manner as described above, except that the serial cable is connected to B18 on the LA30 logic panel.

2.5 UNIT CHECKOUT PROCEDURE

When the LA30 has been installed, its proper operation can be verified by proceeding as follows:

1. Open the cover of the LA30 as far as it will go on its hinges.
2. Make certain that the unit is equipped with a supply of ribbon, threaded through to a take-up reel; it it is not, install the ribbon as outlined in Paragraph 3.2.2.
3. Check that both ribbon reels are mounted firmly on their shafts.
4. Check the end-of-reel switches, through which the ribbon passes, for proper alignment.
5. Check the ribbon roller guides to see that the two barrel-shaped guides are free to rotate, and that all other guides are non-rotating.
6. Check the alignment of the curved paper guide arms; they should not bind the tractor pins.
7. Check the print head gap adjustment as described in Paragraph 5.3.2.
8. Check the main signal harnessing under the rear of the base assembly to see that the harness does not interfere with the operation of the ribbon motor fan blades.

(continued on next page)

9. Install paper as described in Paragraph 3.2.1. When installed, advance the paper manually to see that the sprocket teeth do not elongate the holes in the edge of the paper. If they do, adjust the tractor width, using the black vernier knob concentric with the right-hand drive sprocket.

10. Apply main power to the unit by closing CB1 on the rear of the control box assembly (double breaker on lower left).

11. When the power-up sequence has expired, the READY indicator on the keyboard should light, the fan should run, and the ribbon motors should be running (not activated).

12. Apply motor power by closing CB2 (left-hand breaker on the upper left). The main drive motor should become energized and local line feed should be enabled. Test the line feed function by depressing LOC LF button. If motion is erratic, check the ratchet and pawl adjustment as described in Paragraph 5.3.1.

13. To checkout the LA30 with the system in which it is installed, run the software procedures provided with the unit.

NOTE

Normally, the keyboard does not type directly into the printer. Special "Echo Keyboard" software has been developed for this purpose.

14. Check the copy produced by the checkout routine. The left margin should be 0.750 ± 0.015 in. from the sprocket centerline. If it is not, either or both margins may be erratic (refer to Paragraph 5.3.4 for making this adjustment).

NOTE

Carriage position limit switches do not require adjustment unless they appear damaged.

15. When installation and checkout is complete, return the logic rack to its operating position and replace the back cover of the control box assembly.

CHAPTER 3
OPERATION

This chapter is divided into two major paragraphs. Paragraph 3.1 describes the DECwriter controls and indicators; Paragraph 3.2 contains operating procedures for loading ribbon and paper.

3.1 CONTROLS AND INDICATORS

Controls and indicators for the LA30 are listed in Table 3-1 and shown in Figures 3-1 and 3-2. (Figure 3-1 shows the controls and indicators for the serial version of the LA30; the parallel version has only the READY lamp and the LOCAL LINE FEED switch.)

Table 3-1
LA30 Controls and Indicators

Index	Control/Indicator	Function
1	READY	*Lamp* – Indicates power up on printer electronics and that the DECwriter is READY for use. Indicates an interrupt is enabled by keyboard electronics, if INT bit is set by software.
2	LOCAL LINE FEED	*Switch* – When depressed, causes a local line feed to be applied to the printer without a code being sent out to the computer. This control will also disrupt printing, but no characters will be lost.
3	MODE LOCAL LINE	*2-Position Switch* – Selects either local or on-line operation.
4	BAUD RATE 110, 150, 300	*3-Position Switch* – Selects the baud rate clock frequencies for 110, 150, and 300 baud.
5	MOTOR POWER	*Breaker (CB2)* – Applies power to printer stepping motor electronics.
6	AC POWER	*Breaker (CB1)* – Applies ac power to the unit power supply.

All letter characters always print upper case. Other upper case characters that print are shown in Figure 3-3.

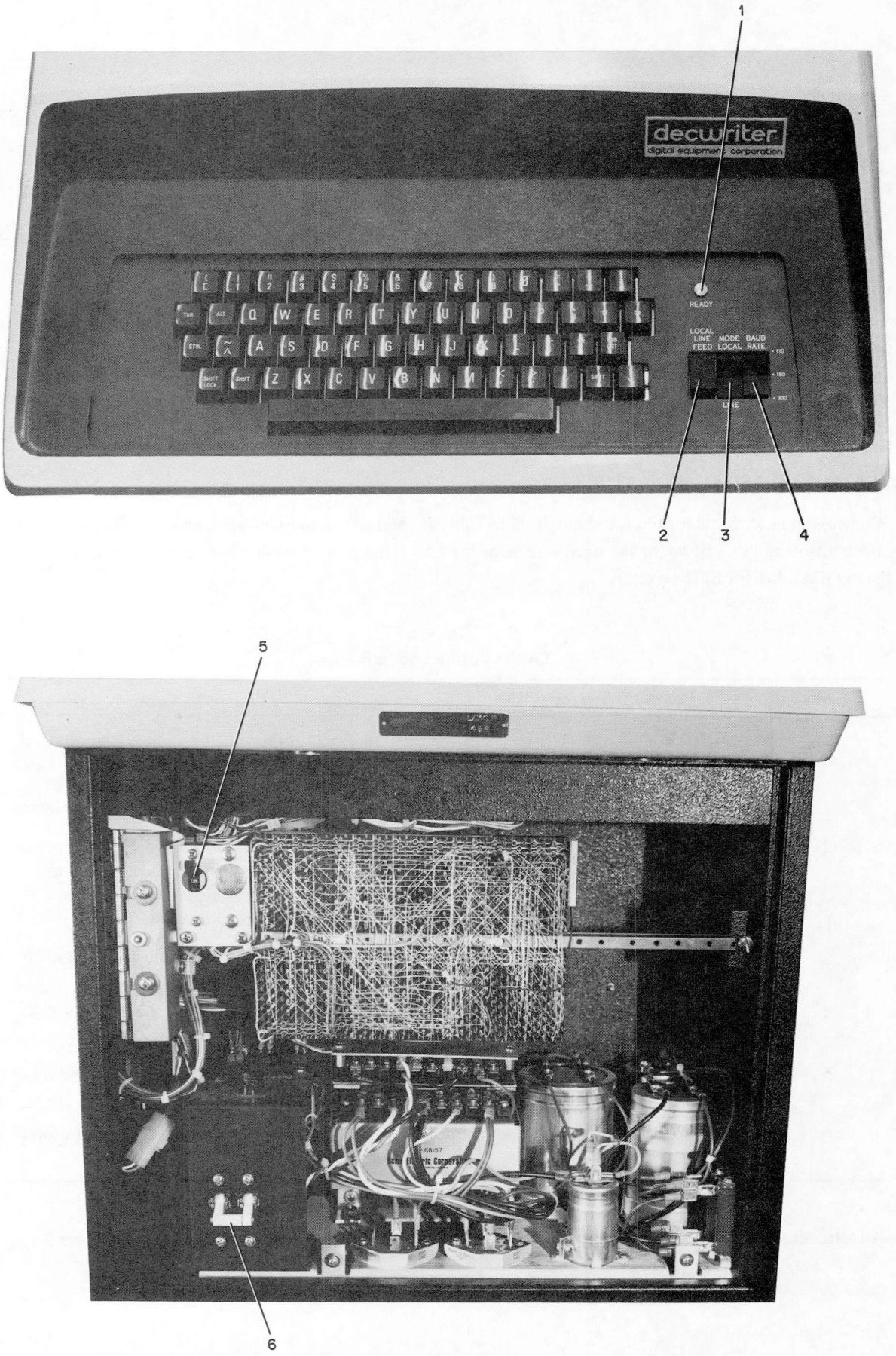


Figure 3-2 LA30 Power Controls

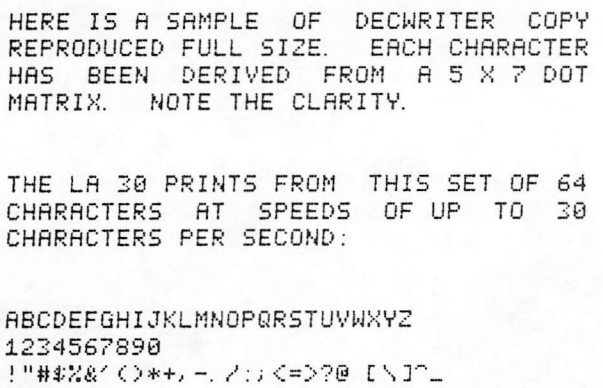

HERE IS A SAMPLE OF DECWRITER COPY
REPRODUCED FULL SIZE. EACH CHARACTER
HAS BEEN DERIVED FROM A 5 X 7 DOT
MATRIX. NOTE THE CLARITY.
THE LA 30 PRINTS FROM THIS SET OF 64
CHARACTERS AT SPEEDS OF UP TO 30
CHARACTERS PER SECOND:
ABCDEFGHIJKLMNOPQRSTUVWXYZ
1234567890
!"#$%&' ()*+,-./:;<=>?@ [\]^_

Figure 3-3 LA30 DECwriter Copy Sample

3.2 OPERATING PROCEDURES

3.2.1 Loading Paper

When loading paper for the first time, or replenishing the supply, proceed as follows:

1. Remove main power at CB1.
2. Open the cover of the DECwriter by pulling up on both sides of the front.

NOTE

When opening the top cover, always release both ball studs from their spring retainers at approximately the same time to avoid skewing the top cover.

3. Raise the cam lever located on the left-hand side of the print bar assembly until it disengages and slide the assembly back on its ways.
4. Feed the paper from its box on the floor under the DECwriter up through the opening in the bottom of the base casting (Figure 3-4). Pull the fresh supply into the machine and discard any remnants of the old supply.
5. Make certain that the paper is feeding straight and re-engage the paper with its sprocket tractor pins.
6. Pull the assembly forward and re-engage it by pressing the cam lever down until it locks in place on its retainer stud. Adjust tractor width, using vernier knob concentric with right-hand drive sprocket. Tractor pins should not elongate holes in paper.
7. Advance the paper by rolling the knobs. Make certain that the paper indexes crisply from one line position to the next. Failure to detent indicates damaged or worn parts (Paragraph 5.3.1).
8. Feed end of paper through the smaller hole in the cover and close the cover, latching both ball studs to the base assembly.
9. Re-apply main power at CB1.

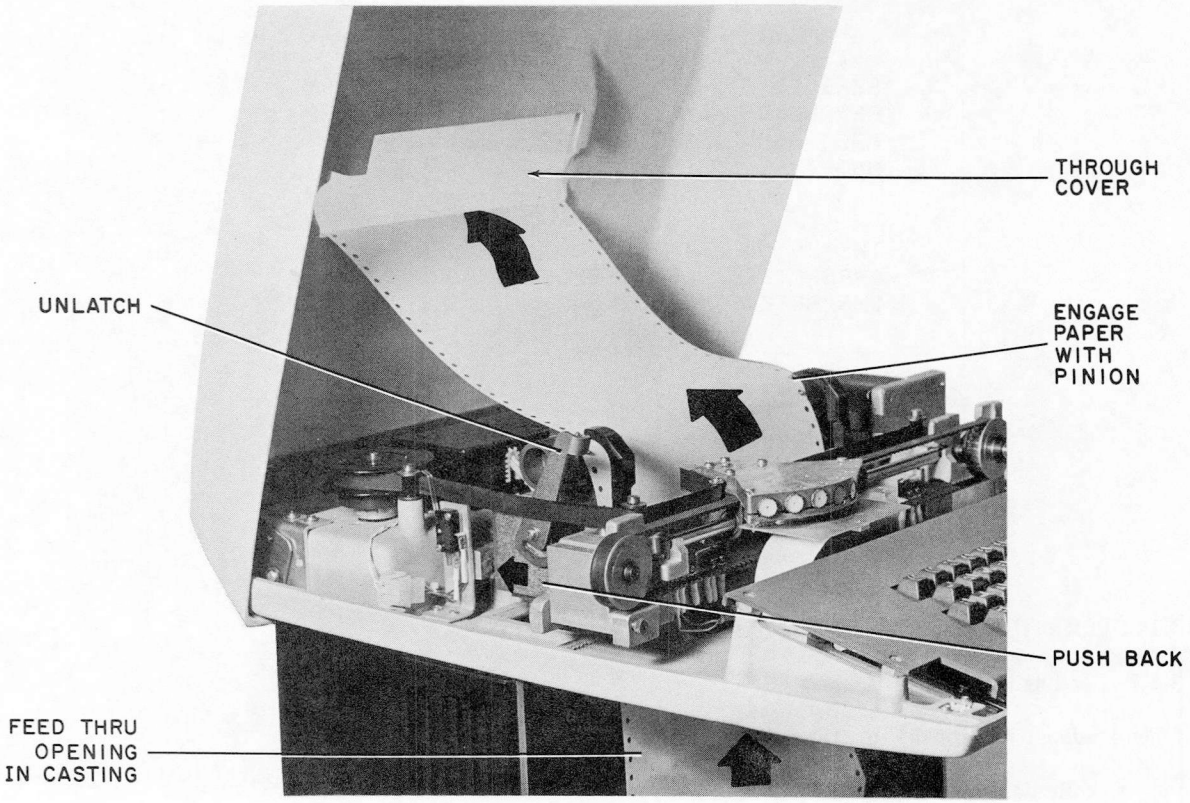


Figure 3-4 Paper Loading and Threading Diagram

3.2.2 Changing Ribbon

When it is necessary to change the ribbon, which under normal operating conditions should be every 10 hours of continuous printing, proceed as follows:

CAUTION

Ribbons left in service for more than 16 hours of continuous printing may function poorly with possible damage to print head.

1. Wait until the present reel has completely emptied and is ready to reverse.

NOTE

Ribbon is supplied on single reels. Greater convenience can be gained by ordering extra take-up reels, making Step 1 unnecessary. See recommended spare parts in Appendix A.

2. Remove main power at CB1.
3. Raise lid and move the platen assembly back as described in Paragraph 3.2.1.
4. Remove ribbon from the idler rollers, the print head, and the direction reversing sense arms.
5. Snap both reels off of their motor shafts, run the ribbon off of the most empty reel, and discard the full reel of ribbon.

(continued on next page)

6. Secure a new reel of ribbon and pay out approximately 1 ft. If the ribbon is not equipped with a hook at its end, skewer the ribbon on the arrow-shaped piece on the take-up reel (Figure 3-5).

7. Wrap the ribbon on the take-up reel beyond the direction-reversing rivet.

CAUTION

If rivet is not between the reel and the sensing arm, the ribbon will not reverse.

8. Snap both reels on their motor shafts and thread the ribbon through the sensing arms and over the idler rollers and print-head assembly as shown in Figure 3-6.

9. Re-engage the platen assembly with its cam lever, close top cover and re-apply main power at CB1.

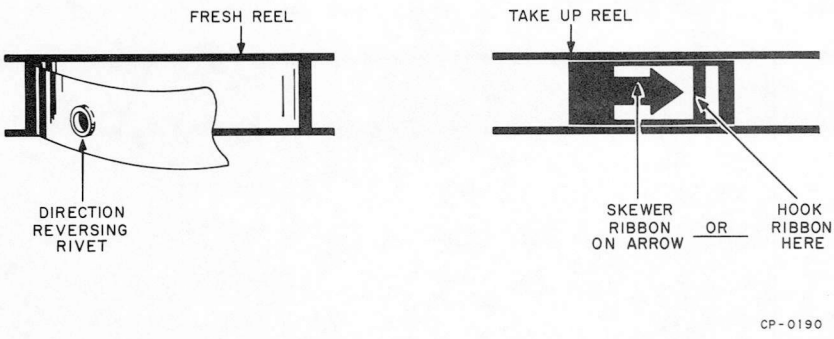


Figure 3-5 Securing Ribbon to Reel

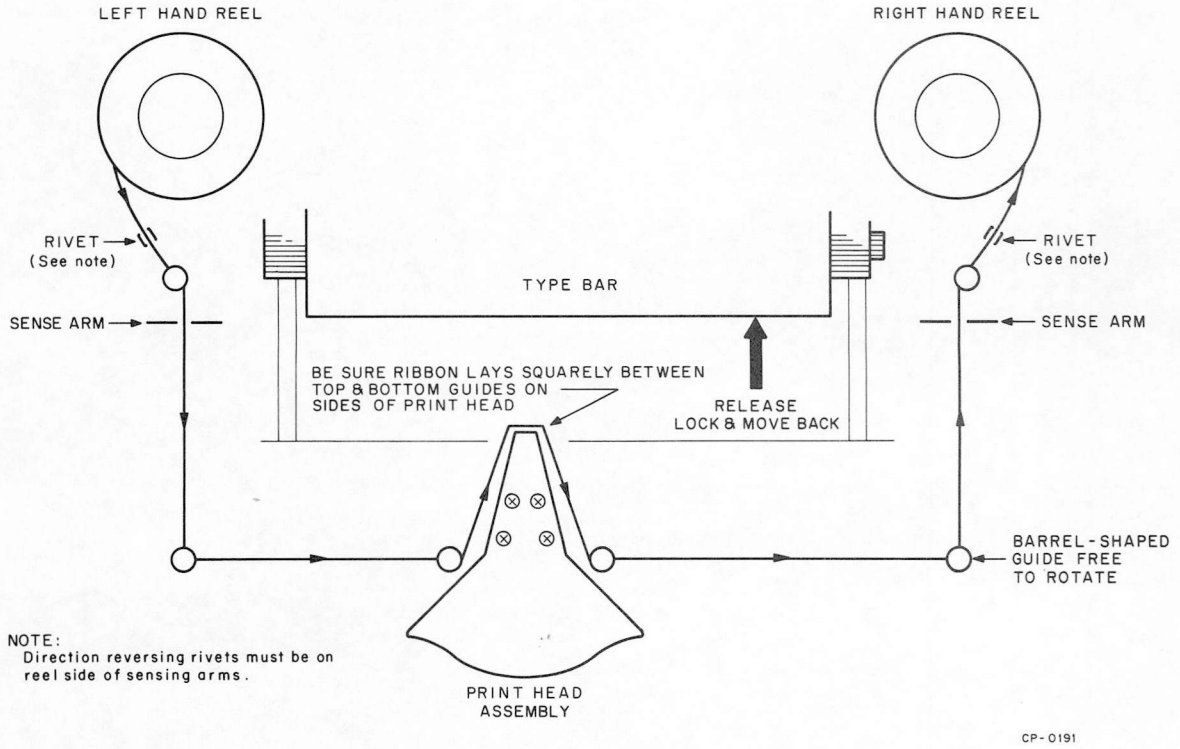

LEFT HAND REEL
RIGHT HAND REEL
RIVET (See note)
RIVET (See note)
TYPE BAR
SENSE ARM
SENSE ARM
BE SURE RIBBON LAYS SQUARELY BETWEEN TOP & BOTTOM GUIDES ON SIDES OF PRINT HEAD
RELEASE LOCK & MOVE BACK
BARREL-SHAPED GUIDE FREE TO ROTATE
NOTE:
Direction reversing rivets must be on reel side of sensing arms.
PRINT HEAD ASSEMBLY
CP-0191

Figure 3-6 Ribbon Threading Diagram

CHAPTER 4
PRINCIPLES OF OPERATION

This chapter contains a description of the LA30 control logic and a basic operating description of each of the LA30 cycles. The logic drawings and circuit schematics are contained in Volume 2 of this manual.

4.1 OVERVIEW

The heart of the LA30 design is the dot matrix impact print head which is moved across the page by a stepping motor. The drive and control system for the printer is completely electronic with no gears, clutches, or other high maintenance parts. Since the print mechanism does not depend on continuously spinning shafts to be ready for immediate operation, the LA30 can be left idle indefinitely with very low power drain.

4.1.1 Dot Matrix

The dot matrix is seven dots high by five dots wide. The character is formed within an area 0.10 in. high by 0.08 in. wide. The print head has seven solenoid-driven print wires. These solenoids are driven selectively to form a vertical row of up to seven dots. The print head is moved across the character cell at high speed by the stepping motor. While the print head is in motion, the print solenoids are enabled five times so that five columns of up to seven dots each are printed. Figure 4-1 illustrates the 5 X 7 pattern for the character "E". The dot patterns for the 64 printing characters are stored in the printer logic in an MOS read-only memory. This simplifies the external printer interface to a 7-bit character code.

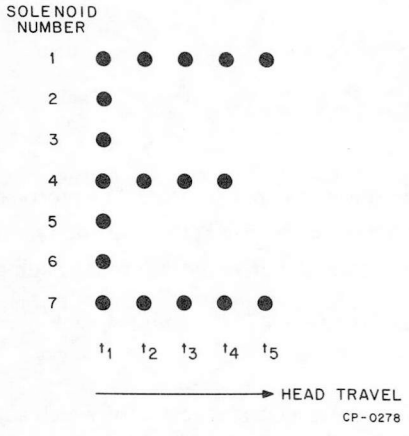


Figure 4-1 5 X 7 Matrix Pattern for Character "E"

The print head carriage is positioned on the print line by a dc stepping motor. The electronic control adapts the motor power to the printer function being performed. When the LA30 is idling, the power is at minimum to hold carriage position, thus preventing heat buildup. While printing, the motor is driven forward at moderate power. When the carriage is to be returned to the left-hand margin, the motor is driven in reverse at maximum power for fast return.

4.1.2 Keyboard

The LK01 Keyboard, used on the LA30, is an all-electronic high-reliability unit which has no contacts.

The keyboard is functionally independent of the printer. Operating a key generates a 7-bit code on the output data lines, and a strobe of about 1 μs duration.

An internal connection is provided to test the keyboard and printer independent of the processor or other data source. If pin AR_2 of the M7712 module is grounded, the connection is made and the printer and keyboard are cut off from the processor.

4.1.3 Electronics

The LA30 electronics are divided into three major parts:

Stepping motor drive control which is composed of the H605 Transistor Drivers for the four-phase stepper motor, the M7717 Current Regulators which adapt the motor drive current to the function being performed, and an M7716 Translator, which is a reversible counter that converts the motor drive pulse train from the control logic into a motor position.

Print head drive and character generation which consists of the G380 Dual-Solenoid Drivers (one driver powers each print solenoid) and the M7724 Character Generator memory which stores the dot pattern for the 64-character LA30 set and selects the G380 driver inputs, and the M7710 Print Sequencer and Memory Timer that times the G380 print pulses and cycles the M7724 memory.

Control logic which is composed of the M7711 Control Logic A and the M7712 Control Logic B. The M7711 controls the relationship of print and carriage return cycles. Also included is a power-up initialize circuit. The M7712 buffers the input signals and detects special characters such as carriage return, bell, and rubout, and identifies printable characters and inhibits illegal printing operations. The M7712 also provides a local loop-back test circuit for the keyboard.

4.2 FUNCTIONAL DESCRIPTION

4.2.1 Motor Drive System

The LA30 print carriage is driven by a 4-phase stepping motor. The motor drive scheme has two of the four phases turned on at any time. This is controlled by the M7716 Motor Translator. This module counts the print step or carriage return pulse trains to generate the drive pattern for the stepping motor.

The selection information goes to one of the two M7717 modules, each of which controls one of the two H605 Power Amplifiers that drive the motor.

The combination of M7717 and H605 includes a current regulator which adjusts the power level of the motor to the function being performed. The "enable" outputs of the M7717 module allow one half of each H605 to be on. A current amplifier on the H605 measures the motor current and returns a proportional signal to the M7717. The M7717 compares the return signal to one of three standards, and adjusts the motor current accordingly.

If no operation is being performed, motor current is very low, just enough to hold the carriage in position. During the carriage return function, the current is maximum to get the best performance from the motor, while the print cycle calls for an intermediate level.

The result is a very "hashy" drive current to the motor which is integrated by the motor inductance to give a constant regulated current.

4.2.2 Control Logic

The LA30 interface operates on a "hand shake" basis. When the "demand" line is high-true, a 7-bit character can be transferred to the printer on the parallel data leads by a "printer strobe" pulse. The demand line then goes false for as long as it takes the printer to process the character. The next character can be sent as soon as the demand line returns high.

Character Code

The character code used is USASCII 68, listed in Table 4-1. This table shows the 7-bit USASCII 68 code, giving the character, binary code, and octal code. For example, the letter "G" has the binary code 1000111, with bit 7, the most significant bit, on the left. The octal representation would be 107. Sometimes an eighth bit is used as the most significant bit, and is always marking. If so, the octal representation for letter "G" would become 307. In some applications, the eighth bit can be used to code parity, either odd or even. In any case, the LA30 neither detects nor acts on an eighth bit, nor does the LK01 Keyboard generate an eighth bit. Serial interface LA30s, which transmit and receive through a serializer, treat the eighth bit differently. For a complete discussion, see the serializer description in Chapter 6.

The USASCII code has three types of characters. Referring to Table 4-1, columns 0 and 1 (codes 000_8 to 037_8) are non-printing control characters. Some of these codes are used to start printer functions:

007_8 – BEL causes LA30 "beep" (also beeps when 64 characters have been typed on one line).

012_8 – LF, Line Feed, advances paper one vertical line. Time 33 ms.

015_8 – CR, Carriage Return, sends the print head to left-hand margin. Time 300 ms or less depending on column position.

Columns 2, 3, 4, and 5 are the LA30 character set. Sending one of these characters starts a 33 ms print cycle and advances the print head one column to the right.

When a character is received, the demand line goes false on the leading edge of the strobe pulse. If the character is non-printing, and does not start a control function, the demand line will be returned high within 10 μs.

All printing characters, as well as line feed, hold the demand line down for between 30 and 33 ms.

If more than 80 printing characters are sent without a carriage return, the right-hand margin switch will be operated. This causes succeeding printing characters to be treated as non-printing and the demand line will return in 10 μs after each one. Line feed will function normally throughout. A carriage return will restore normal operation.

Carriage Return

When carriage return (015_8) is detected, the stepping motor is reversed and the carriage is started toward the left-hand margin at high speed (up to 50 in./sec). The return takes up to 300 ms, depending on starting position in an odd way, as shown in Figure 4-2.

Table 4-1
LA30 Character Codes
(USASCII 68)

				Col. 0	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
			bit 7	0	0	0	0	1	1	1	1
			bit 6	0	0	1	1	0	0	1	1
			bit 5	0	1	0	1	0	1	0	1
b_4	b_3	b_2	b_1								
0	0	0	0	NUL 000_8	DLE 020_8	SP 040_8	0 060_8	@ 100_8	P 020_8	` 140_8	p 160_8
0	0	0	1	SOH 001_8	DCI 021_8	! 041_8	1 061_8	A 101_8	Q 121_8	a 141_8	q 161_8
0	0	1	0	STX 002_8	DC2 022_8	" 042_8	2 062_8	B 102_8	R 122_8	b 142_8	r 162_8
0	0	1	1	ETX 003_8	DC3 023_8	# 043_8	3 063_8	C 103_8	S 123_8	c 143_8	s 163_8
0	1	0	0	EOT 004_8	DC4 024_8	$ 044_8	4 064_8	D 104_8	T 124_8	d 144_8	t 164_8
0	1	0	1	ENQ 005_8	NAK 025_8	% 045_8	5 065_8	E 105_8	U 125_8	e 145_8	u 165_8
0	1	1	0	ACK 006_8	SYN 026_8	& 046_8	6 066_8	F 106_8	V 126_8	f 146_8	v 166_8
0	1	1	1	BEL 007_8	ETB 027_8	' 047_8	7 067_8	G 107_8	W 127_8	g 147_8	w 167_8
1	0	0	0	BS 010_8	CAN 030_8	(050_8	8 070_8	H 110_8	X 130_8	h 150_8	x 170_8
1	0	0	1	HT 011_8	EM 031_8	) 051_8	9 071_8	I 111_8	Y 131_8	i 151_8	y 171_8
1	0	1	0	LF 012_8	SUB 032_8	* 052_8	: 072_8	J 112_8	Z 132_8	j 152_8	z 172_8
1	0	1	1	VT 013_8	ESC 033_8	+ 053_8	; 073_8	K 113_8	[133_8	k 153_8	{ 173_8
1	1	0	0	FF 014_8	FS 034_8	, 054_8	< 074_8	L 114_8	\ 134_8	l 154_8	: 174_8
1	1	0	1	CR 015_8	GS 035_8	- 055_8	= 075_8	M 115_8	] 135_8	m 155_8	} 175_8
1	1	1	0	SO 016_8	RS 036_8	. 056_8	> 076_8	N 116_8	^ 136_8	n 156_8	~ 176_8
1	1	1	1	SI 017_8	US 037_8	/ 057_8	? 077_8	O 117_8	_ 137_8	o 157_8	DEL 177_8

The demand line is returned high within 10 μs of the start of the carriage return. Characters can be accepted while the carriage return is in progress. The character following carriage return is normally a line feed. If so, the demand line goes low for 33 ms while the line feed is executed and then returns high. This allows the functions that do not interfere to be overlapped in time.

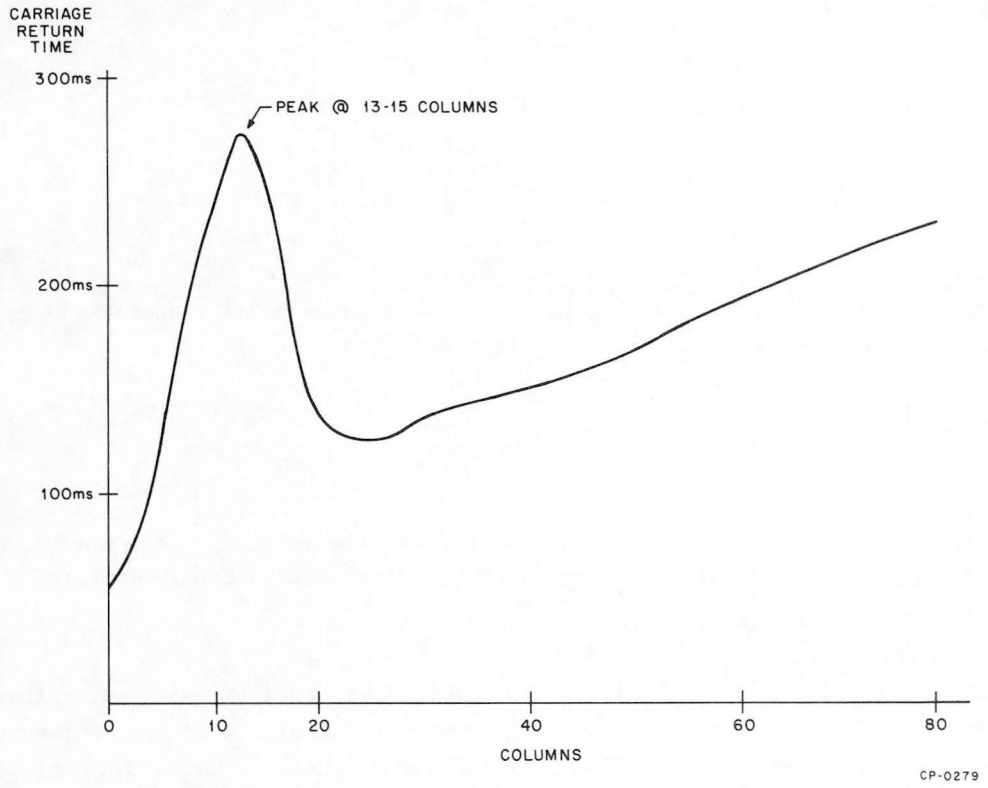


Figure 4-2 Carriage Return Time

Any printing character received while the carriage return is in progress will be stored and the demand line will stay low until the carriage return is complete and the stored character is printed.

Initialization

The interface includes an initialize lead, which allows the processor to set initial conditions in the LA30 during power-up. Internal circuits in the LA30 provide this function when the LA30 is powered up separately. The LA30 will raise the demand line about 500 ms after power is turned on.

For each of the operations of the LA30 (printing, line feed, carriage return, etc.) there is a path through the control logic to generate timing and power the mechanism. The logic is interlocked to prevent interference.

The following sections describe the operation of each of the LA30 cycles.

4.3 OPERATING CYCLES

4.3.1 Print Cycle

The LA30 print mechanism has two parts: a dot matrix print head and a stepping motor. The print head makes up to seven dots at once in a vertical row. The stepping motor moves the head horizontally across the page, one character space at a time. To form a character, the print head is put in motion across the character space, and each of the seven print wires makes up to five dots in a horizontal row. The dots in this 5 X 7 matrix are selected by a read-only memory in the control logic, which contains the dot patterns for the 64 character LA30 set. The LA30 control logic coordinates the operation of the stepping motor and print head.

The steps in the print cycle are:

1. Identify printing characters
2. Start function times
   a. Motor step
   b. Memory cycle
3. Print

4.3.1.1 **Identify Printing Characters** – The "character print" signal from the M7712 module initiates the print cycle. This signal indicates that:

a. Strobe is true.

b. Bits 6 and 7 are not both zero (control character).

c. The character is not "DELETE" (all ones).

d. A demand line cycle has been completed since the last strobe was received. This feature also prevents acting on characters which might be sent (illegally) without waiting for the demand line.

e. Print carriage is not at right-hand margin.

4.3.1.2 **Start Function Timers** – The "character print" pulse goes to the M7711 module where extensive gating controls the relationship of the print and carriage return cycles. The important function is the generation of "print start" and "memory start" signals. These two signals start the print cycle timing. The print cycle timing is controlled by the M7710 module which has three independent timers.

The print timer generates the pulses needed to advance the stepping motor through one character space. The memory timer calls up the five columns of dots from the memory and enables the solenoid drivers.

The third timer controls the "ready" line which indicates that the print cycle is running.

The READY timer holds the ready line low for between 30 and 33 ms after the "print start" signal is received. READY low acts on the M7712 module to inhibit the demand line.

The print motor step pulses are timed to accelerate the stepping motor to high speed, hold it at speed while printing is done, and then stop the motor.

The memory timer interacts with the M7724 Character Generator Memory to actually control the print solenoid drivers. The code for the character to be printed is stored in a 6-bit buffer register and addresses the MOS read-only memory which contains the dot patterns for the 64 character set. A sequence of six memory clock pulses from the M7710 module calls up the five columns of seven dots, in turn, and then clears the memory. The "head drive enable" signal from the M7710 is a common input to the G380 print head drivers, providing timing; the "head select" outputs of the M7724 provide the selection logic. For each of the seven print wires there is a separate drive channel from the read-only memory to the G380 Power Amplifier to the print solenoid.

4.3.2 Carriage Return Cycle

The carriage return function brings the print head to the left-hand margin of the page. It is started by receiving a carriage return code 015_8. The code is detected on the M7712 module. The detected code is gated on the M7711 module with the strobe and a carriage return non-repeat flip-flop, to produce a carriage return function start pulse, which starts the G936 Clock Accelerator. The G936 acts on the M7716 Counter to reverse the motor and generate a pulse train to drive the print head at high speed toward the left-hand margin. The demand line is

returned high as soon as the function is started. This allows the printer to "double up" on functions which do not interfere with one another. For example, "carriage return" is usually followed by "line feed". When the demand line is returned high following the start of the carriage return cycle, the line feed cycle can be started immediately. The demand line will be taken down during the 33 ms line feed cycle, then returned to allow receipt of the next character.

Any number of characters can be received during the carriage return function, as long as they are non-printing characters. The first printing character received will be stored in the buffer of the M7724 module and the demand line will be held down by the WAIT logic of the M7711 module.

At the end of the carriage return cycle, the WAIT logic will generate a "Character Start" pulse which will start a delayed print cycle to print the stored character.

4.3.3 Line Feed Cycle

This function is started by detecting the 012_8 code on the M7715 module or by depressing the local line feed button. The demand line is held down during the function by the "line feed function low" output of the M7715. "Solenoid select" is used to turn on the eighth G380 amplifier, which drives the G381 Line Feed Solenoid Driver.

4.3.4 Character Visibility Cycle

The LA30 print head slightly obscures the character being printed. This presents no problem at the normal LA30 print rate of 300 words per minute; but when the printer is used for manual data entry, it is desirable to see the last printed character.

If there is a delay of one second or more between printing characters, a character visibility cycle is started. Automatically, the print head is stepped two character spaces to the right and ribbon motion is stopped.

When the next printing character is received, the ribbon is restarted, the print head is stepped two spaces left, and the character is printed.

A carriage return code overrides the character visibility cycle. The cycle is controlled by the M7713 module, which also has drivers for the electric ribbon clutches.

4.4 POWER FAIL (Drawing D-CS-G8004-0-1)

The power fail logic is used when the LA30P is powered down independently from computer power. Signals PDEM and KEYSTB are held low during power down to inhibit the generation of a burst of interrupts.

Transistor Q1 on the G8004 module compares the PINIL L line from the processor and the LA30 +5V supply. If the +5V in the LA30 goes below the 3V threshold, Q1 turns off slowly. As Q2 turns on slowly, the emitter of Q1 jumps from +2.25V to +3.1V causing Q1 to turn off sharply. With Q2 on, Q4 and Q5 turn on and hold signals PDEM and KEYSTB low. Normal switching time is 150 ns.

NOTE

Earlier versions of the M7711 module may contain the 220Ω resistor that pulls up the PINIL line. It is essential that this resistor be replaced with a 2.2K resistor to allow the G8004 module to function correctly.

CHAPTER 5
MAINTENANCE

5.1 INTRODUCTION

This chapter contains preventive and corrective maintenance procedures for the LA30 DECwriter. Table 5-1 lists any special test equipment and alignment tools required to perform these maintenance procedures in excess of standard tools and equipment. Appendix A contains a complete illustrated parts breakdown (IPB) and associated parts list for the LA30. Those items in the parts list that are recommended spares are designated.

Table 5-1
LA30 Recommended Test Equipment and Alignment Tools

Equipment	Manufacturer	Designation
Multimeter	Triplett or Simpson	Model 630-NA or 260
Oscilloscope	Tektronix	Type 453
Clip-on Current Probe	Tektronix	Type P6016
X10 Probe	Tektronix	P6008
Recessed Tip, 0.065 in. for wire-wrap terminals	Tektronix	206-052
Hand Unwrapping Tool	Gardner-Denver	500130
Hand-Operated Wire-Wrap Tool with a 26263 bit for 24 AWG Wire and 18840 Sleeve	Gardner-Denver	14H1C
Module Extender	DEC	Type W980
Diagnostic Self-Test Routine	DEC	

A preventive maintenance (PM) schedule has been established to ensure optimum operation of the LA30 DECwriter. The PM schedule is presented in Table 5-2. The cleaning, inspection, and replacement tasks listed in Table 5-2 are explained in Paragraphs 5.2, 5.3, and 5.4, respectively. Data obtained while performing preventive and corrective maintenance should be entered in the LA30 maintenance log book. Access to the interior components of the DECwriter is gained by snapping the cover open at the two front ends (Figure 5-1). Access to the rear control box assembly is gained by removing the back cover (one thumbscrew) and a thumbscrew fastener on the logic rack, which then swings out on its hinges.

Table 5-2
LA30 Preventive Maintenance Schedule

Printing Interval (Hours)	Clean	Inspect
300 – 500	1. Ribbon Idlers clean with oiled cloth (Para. 5.2)	1. Ribbon Tension (Para. 5.4.6)
2000	1. Ribbon Motors (Para. 5.2) 2. Carriage Assy Round Shaft (Para. 5.2) 3. Ventilating Fan Blades, if necessary (Para. 5.2) 4. Linkage Pins, Ratchet and Pawl Mechanism (Para. 5.2)	1. Ribbon Tension (Para. 5.4.6)

5.2 CLEANING PROCEDURES

When cleaning the LA30, always use a clean, lint-free cloth to wipe off outside surfaces and a lightly oiled cloth inside the unit to remove any dust or ink accumulation (ink is oil-base). The outside of the cover can be protected with commercial furniture or automotive wax. The cover can be dusted when paper is replenished and the keyboard can be wiped clean at these times.

The print head assembly should never be cleaned; rather, it should be replaced whenever printing operation is affected by a head failure. For the procedure to remove and replace this assembly, refer to Paragraph 5.4.2. At this point in the preventive maintenance schedule, the ribbon idlers should be wiped clean with an oiled cloth.

Every 2000 hours of printing operation, each ribbon motor should be removed as described in Paragraph 5.4.5 and a light oil applied to the lower bearing felt. At this point in the maintenance schedule, the carriage assembly round shaft (P/N 74-8656-1/2) should be lubricated. Spray a light coating of Molykote 557 along the entire shaft and wipe lightly with dry cloth to leave a thin film of lubricant on the shaft.

The control box assembly should never be cleaned or vacuumed. As with all power supply installations, they function better if left alone. If desired, at the 2000-hour point, the fan can be removed and the blades wiped clean with an unoiled cloth. The fan motor never needs to be oiled.

At the 2000-hour interval, the paper advance mechanism linkage pin and pivot pins should be checked for the presence of grease and freedom of motion. Normally, no maintenance is required; however, in extreme environments, or if the pins have inadvertently been wiped free of grease, they will require relubrication with Molykote B2KR grease. Linkage must be disassembled and grease applied to bearing surfaces.

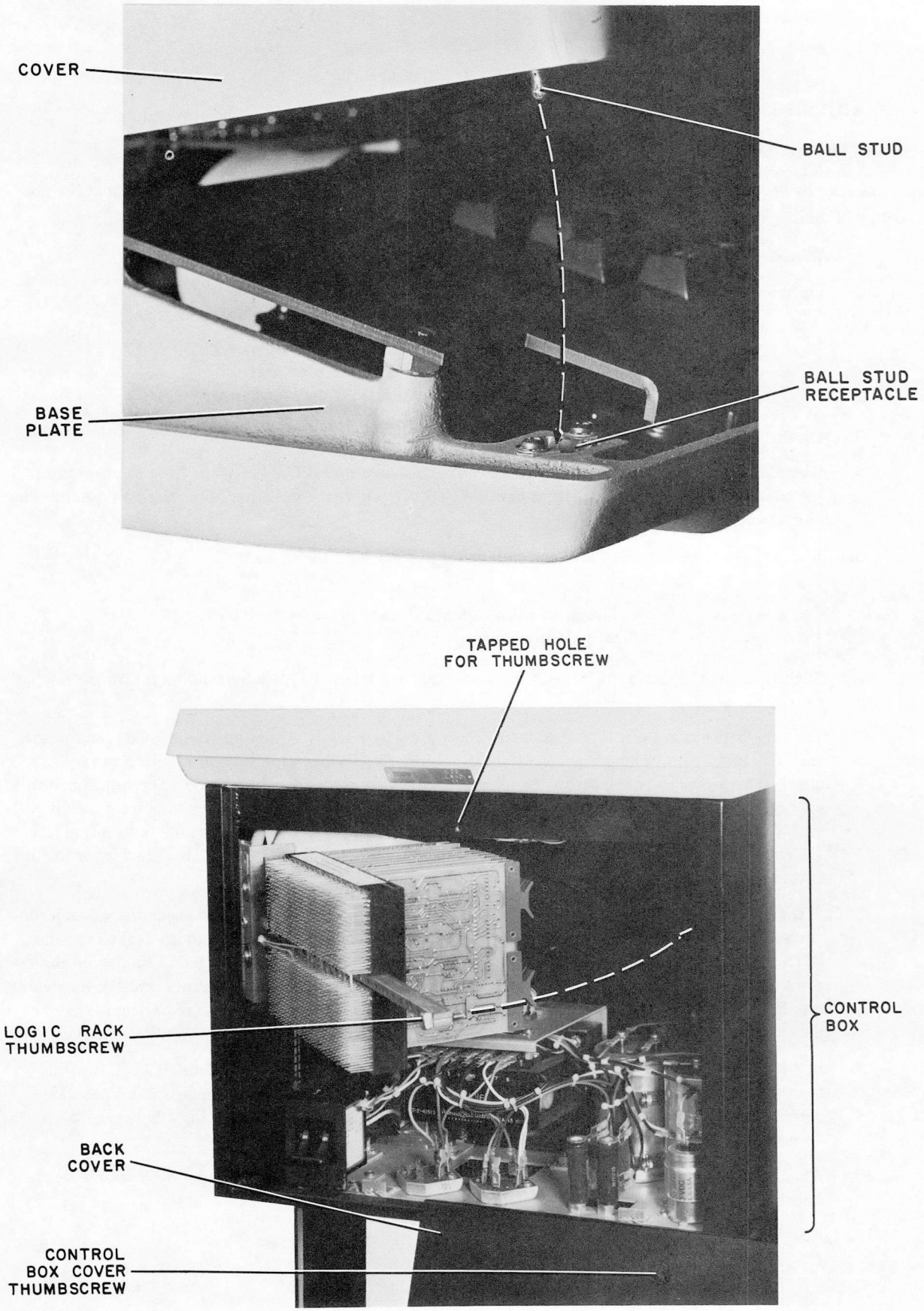


Figure 5-1 LA30 Component Access

5.3 ADJUSTMENT PROCEDURES

5.3.1 Line Feed Pawl and Detent

If line spacing becomes erratic (i.e., sometimes overprint, sometimes double space), indications are that the line feed mechanism is out of adjustment. Proceed as follows:

1. Remove main power at CB1.
2. Open and remove the cover.

NOTE
The cover hinge is secured with spring washers and truarc rings on ends of the hinge shaft. When removed, the cover can be sprung off the hinge shaft.

3. On the line feed solenoid (Figures 5-2 and 5-3), loosen the adapter locknut.
4. With the solenoid in rest position, rotate the solenoid armature (CCW as viewed from the top) until the tooth of the pawl contacts the ratchet tooth (dotted position in Figure 5-2). Mark a reference line on the solenoid and armature.
5. Back the armature off (CW) 3/4 turn and lock it in place with the locknut.

NOTE
The pitch of the armature screw provides the 0.036 in./turn adjustment.

6. Slightly rotate the ratchet (CW) with the knob and then release. The detent should return the ratchet to rest.
7. Load the paper into the machine as described in Paragraph 3.2.1. Apply power with CB1, and push the LOC LF button. The paper should advance properly. Proper paper advance motion can be checked by moving a pencil across the page while depressing the LOC LF button. The top edge of the carriage support casting can be used as a straight edge to guide the pencil. The pencil trace produced should appear as shown in Figure 5-4. The overshoot should be less than 1/4 of the full motion (i.e., less than 1/4 of 1/6 in. or 0.040 in.). If the overshoot is greater than 0.040 in., the pawl is set too low. If there is not overshoot (less than 0.010 in.), the pawl is set too high.
8. If the above conditions cannot be met, recheck the 0.027 in. adjustment. Also check the solenoid position. The center of the solenoid should be vertically in line with the ratchet tooth at the beginning of its stroke. The aluminum solenoid mounting plate edge should be recessed 0.062 in. behind the print bar surface. The solenoid should also be positioned such that the pawl passes through the detent arm freely without touching it; the roller arm should also move freely. If these requirements can be met, the adjustment should be possible.
9. If the feed is still not functioning properly, the electrical constants can be at fault. Check the resistance of the solenoid coil; the resistance should be $3.2 \pm 0.17\Omega$. The driver voltage should be 25V with $1.0 \pm 0.1\Omega$ in series with the solenoid coil. The solenoid "on" time should be between 14 and 18 ms.
10. When the adjustment is complete, replace the cover. Make certain that the paper drive sprockets do not bind on the cover.
11. Re-apply power, if necessary, at CB1.

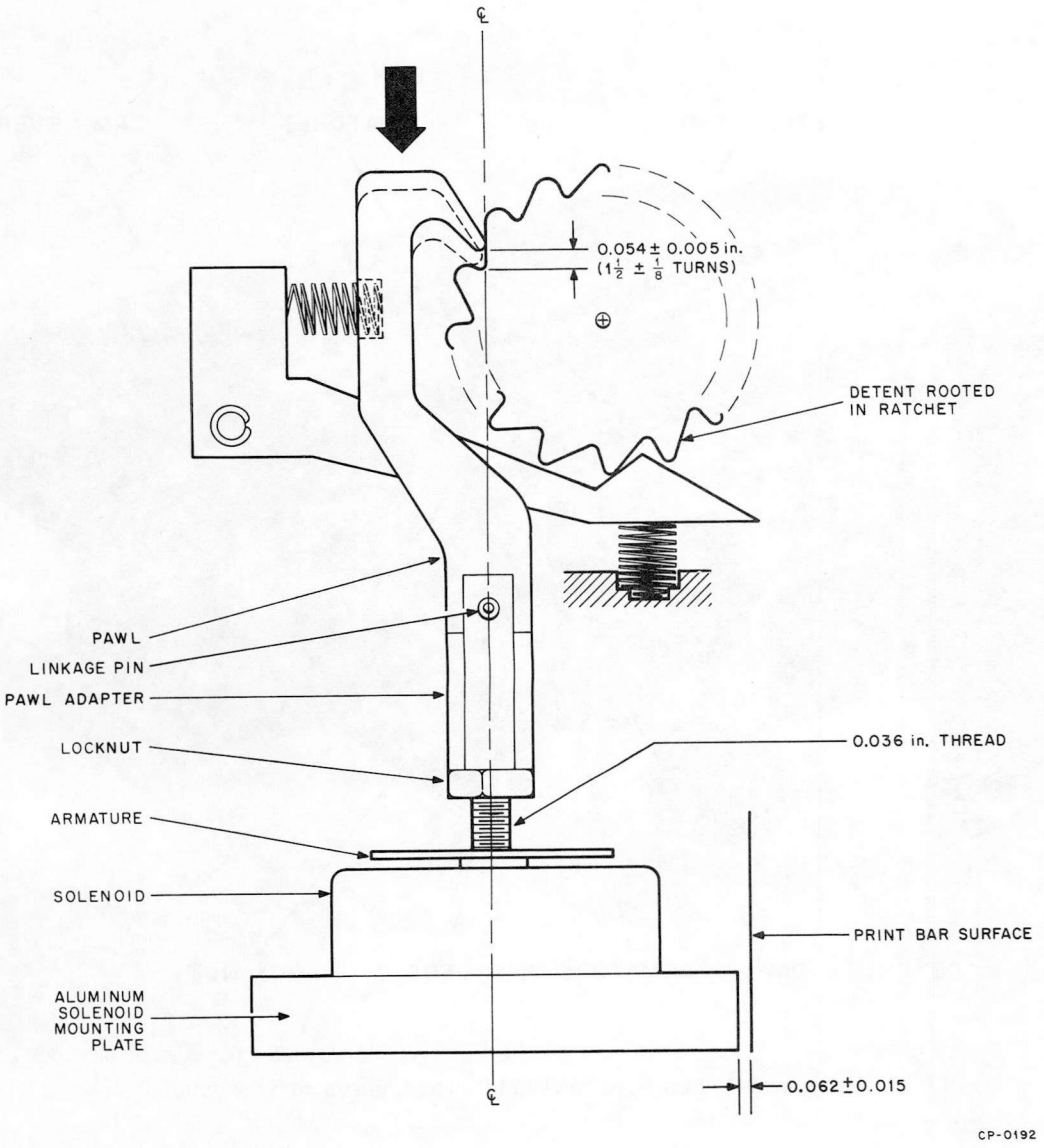


Figure 5-2 Line Feed Pawl and Detent Adjustment Schematic

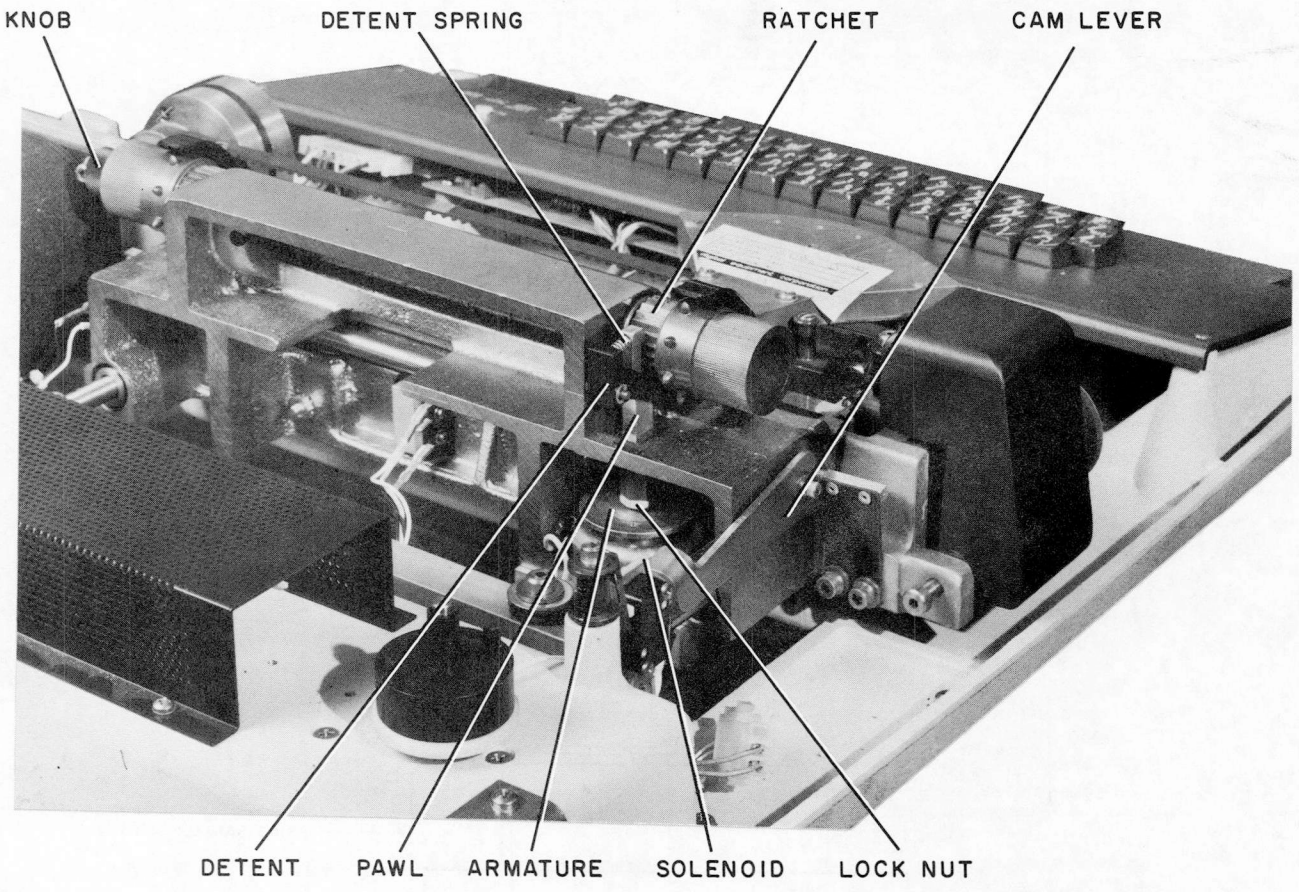


Figure 5-3 Line Feed Pawl and Detent Adjustment Schematic

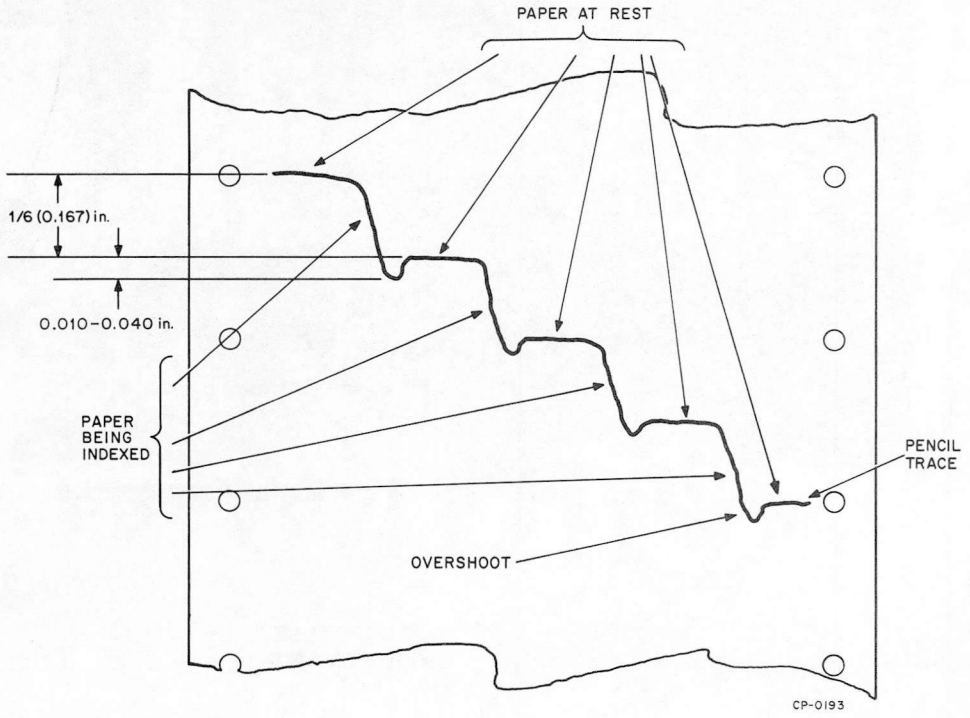


Figure 5-4 Checking Paper Advance Motion

5.3.2 Print Head

The print head adjustment is made both electrically and mechanically. The electrical adjustment ensures that the print pulse is of proper duration; the mechanical adjustment sets the distance the print wires must travel to make a proper impression on the paper.

To adjust the length of the print pulse (HD DRV ENA H), proceed as follows:

1. Remove the rear cover and open CB2. This removes power to the head circuitry. Swing the logic rack out on its hinges.
2. Using the oscilloscope and probe, look at the print pulse on B8N2. The positive pulses should measure 650 μs. If not, adjust R36 on M7710 (10K micropot) available from the module side of the rack (Figure 5-5).
3. When the adjustment has been made, resecure the logic rack with its thumbscrew and proceed with the mechanical adjustment.

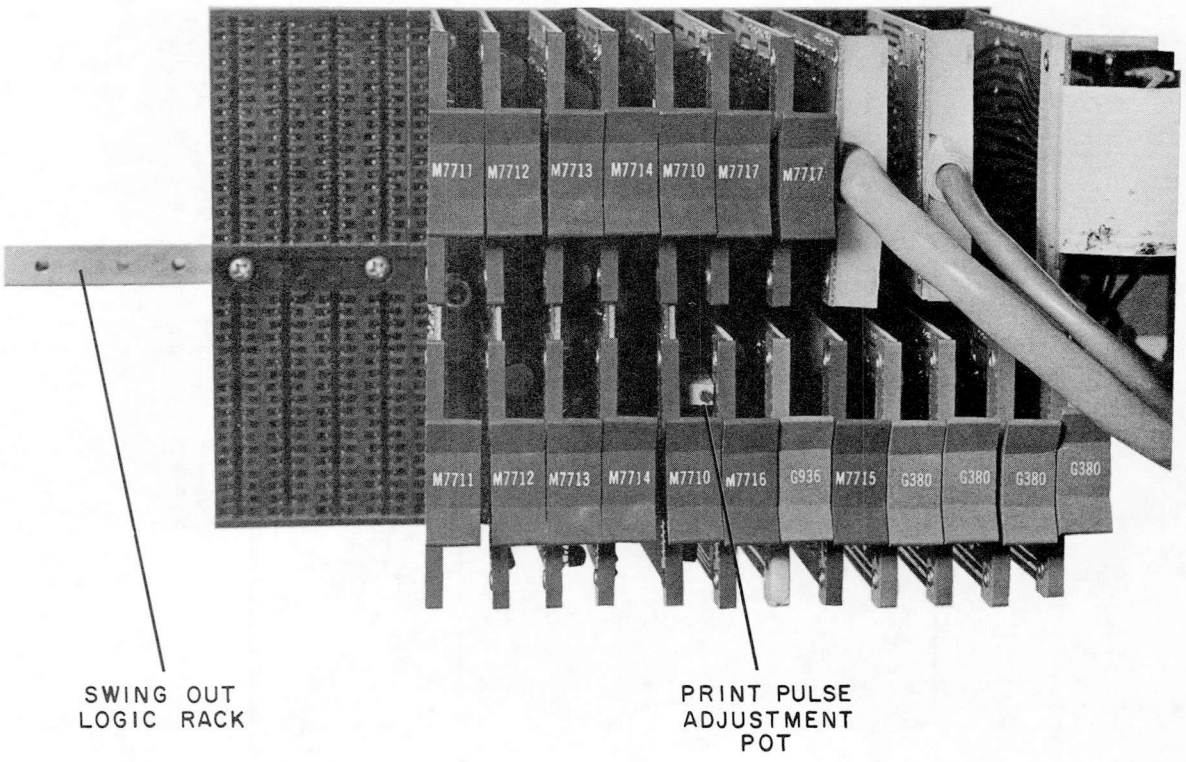


Figure 5-5 Print Pulse Micropot

To perform the mechanical adjustment of the print head assembly, refer to Figure 5-6 and proceed as follows:

1. Ensure that CB2 is open.
2. Remove the paper from the machine and the ribbon from the front of the print head.
3. With the carriage positioned in the center of the page, check the clearance (by feeler gauge) between the end of the print wires and the type bar when the type bar assembly is latched in place with the cam lever. The clearance should measure 0.012 in. (the gauge should be snug with light drag).

NOTE

The small flat plate (trapezoidal in shape) on the top of the nose of the head extends beyond the ends of the print wires and is not intended to be used in setting the print gap. Make certain the feeler gauge is below this plate.

4. If the measurement is out, slightly loosen the four screws that fasten the print head assembly to the carriage and adjust the print head until it is perpendicular to, and snug against, the gauge.
5. Tighten the screws and recheck the adjustment.
6. Make certain that the clearance is between 0.010 and 0.015 in. at each end of carriage travel. If necessary, compromise so that the tolerance is achieved over the entire carriage travel. If this cannot be achieved, the print quality will be poor. The printer must be returned to the depot for overhaul.
7. When the adjustment is made, replace the ribbon and paper. Close CB2 and replace the rear cover on the control box.

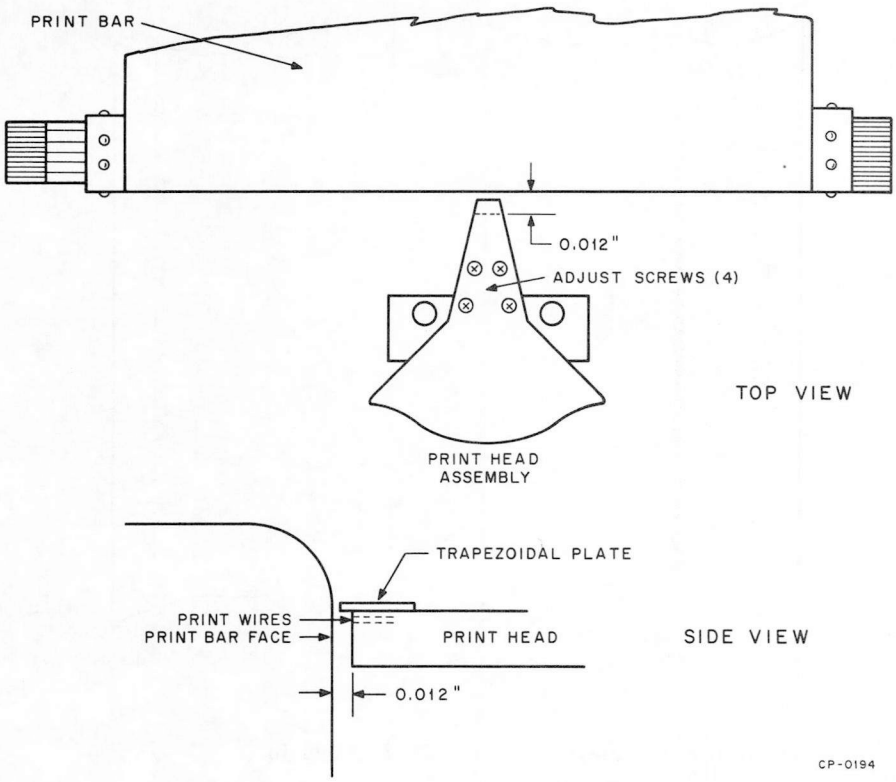


Figure 5-6 Print Head Adjustment

5.3.3 Impact Loading

The LA30, as shipped, is adjusted to print either a single sheet or one copy. It is not recommended that this adjustment be altered.

5.3.4 Left and Right Margin

When the left-hand margin is properly set, the right-hand margin will be set automatically. To adjust the margins, proceed as follows:

1. Prepare a length of paper from the LA30 paper supply by drawing in a reference line in pencil or ink 0.750 ± 0.010 in. in from the left-hand sprocket hole centerline, and parallel to the sprocket hole centerline (Figure 5-7).
2. Using this paper, the margins in the printer will be set correctly when the left edge of the character "E" printed in the first position after a carriage return coincides with the center of the reference line.
3. The position of the first character is adjusted by loosening the splined setscrew on the drive pulley and then rotating the drive pulley on the shaft extension to correct the error found in Step 2. Retighten setscrew to at least 14 in. lb before testing.
4. If the above conditions cannot be met, it is probable that the left-hand margin switch is damaged, worn, or improperly mounted. Re-adjust or replace the switch and repeat Steps 2 and 3.

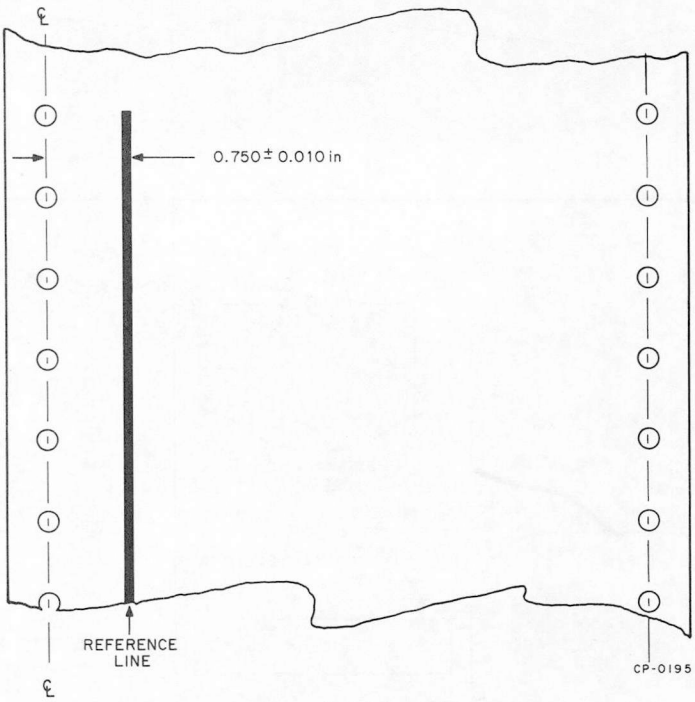


Figure 5-7 Checking Left Margin

5.4 REPLACEMENT PROCEDURES

Perform the following procedures only after it has been determined that the assembly or subassembly in question is defective. In each paragraph, it is assumed that the procedure begins with a completely assembled LA30. Any special tools required for these operations are listed in Table 5-1.

5.4.1 Keyboard Assembly

To replace the LA30 keyboard, proceed as follows:

1. Turn off main power at CB1.
2. Raise the top cover.
3. Remove and set aside the four Flat Head No. 6-32 screws that secure the keyboard bezel to the base assembly.
4. Unplug the connector to the LOC LF switch and the READY indicator.
5. Remove the keyboard bezel and set it aside.
6. Remove the cable connector from the back of the keyboard assembly.
7. Remove and set aside the four Philister Head No. 6-32 screws that secure the keyboard assembly to the base plate.
8. Remove the keyboard assembly and replace with new assembly in reverse order (keys must not bind on bezel).

NOTE
Put the mode selector switch located on the new keyboard in same position as that removed.

5.4.2 Print Head and Cable Assembly

To replace the print head and cable assembly (they are inseparable), proceed as follows:

1. Turn off main power at CB1.
2. Raise the top cover.
3. On the back of the unit, loosen the captive screw at the center of the top of the cover. Remove the cover and set aside.
4. Open the logic rack by disengaging the thumbscrew fastener and remove the print head connector in location A05.
5. Fish the cable and connector up through the opening provided in the base plate, and free the cable all the way to the print head assembly.
6. Remove the four Philister Head No. 6-32 screws that secure the print head assembly to the carriage.
7. Remove the assembly and replace with new in reverse order.
8. When installed, reset the mechanical head alignment as described in Paragraph 5.3.2.

5.4.3 Carriage Assembly

To replace the carriage assembly, proceed as follows:

1. Turn off main power at CB1.
2. Raise the top cover.
3. Remove and set aside the four Philister Head No. 6-32 screws that secure the print head assembly to the carriage.
4. Remove the head and set aside.

CAUTION

Use care not to break cable connections to the print head assembly.

5. Remove and set aside the two Philister Head No. 8-32 screws that secure the carriage assembly round shaft clamps.
6. Disengage the drive belt from the carriage and remove the carriage and the shaft from the unit.

NOTE

Carriage and round shaft are mated items. See notes on Drawing C-IA-7408933-0-0.

7. Before installing new carriage and shaft, spray a small amount of Molykote 557 lubricant in each ball bushing. Coat all ball tracks. Spray shaft and wipe lightly with a dry Kimwipe to leave a thin lubricant film.

CAUTION

Lubricant is critical during break-in period of new bushings and shaft. Lack of it will cause premature failure.

8. Replace the new carriage and shaft in reverse order.
9. Check assembly for freedom of travel on square shaft.
10. Re-install the print head assembly and reset the mechanical head alignment as described in Paragraph 5.3.2.

5.4.4 Print Bar Assembly

To remove the print bar assembly, proceed as follows:

1. Remove main power at CB1.
2. Raise and remove the cover.

NOTE

The cover hinge is secured with spring washers and truarc rings on ends of hinge shaft. When removed, the cover can be sprung off the hinge shaft.

3. Remove and set aside four No. 6-32 screws that secure the module board shield for the line feed solenoid driver. Disconnect the solenoid leads from their source. Disconnect the "paper-out" switch.
4. Loosen the two socket setscrews that secure the support bar to the backstop ways.
5. Remove and set aside the support bar.
6. Raise the cam lever to disengage the print bar assembly and slide the assembly back off the backstop ways. Save the two rubber mount rings for reinstallation.
7. Replace with new assembly in reverse order. In reassembly, support bar must be located 1-5/8 in. from print bar with cam lever engaged.

NOTE

Rubber-mounted ball bushings must be pressed into print bar casting just prior to installing the print bar assembly on the backstop ways. First lubricate the rubber mounts with soap solution and press in with thumb. When in place, the rubber "firms up" within 12 hours to freeze the alignment of the ball bushings; hence, to guarantee proper alignment of ball bushings, this "firming up" must be done with the assembly in clamped position on the backstop ways.

8. When installed, check the print head adjustment (Paragraph 5.3.2) and the line feed adjustment (Paragraph 5.3.1).
9. Replace cover and re-apply power at CB1.

5.4.5 Ribbon Drive Motor

To remove and/or replace a ribbon drive motor, proceed as follows:

1. Remove main power at CB1.
2. Raise and remove the cover.

NOTE

The cover hinge is secured with spring washers and truarc rings on ends of hinge shaft. When removed, the cover can be sprung off the hinge shaft.

3. Remove the snap ring on end of motor output shaft and slide clutch and drive spool off of the shaft.
4. Remove the cover to the control box assembly and swing out the logic rack on its hinges (2 captive thumbscrews). Disconnect the quick-disconnect carrying ac power to the motor.
5. Reach up under the base casting and hold the motor.

(continued on next page)

6. Remove and set aside the three counter-sunk Phillips Head screws that secure the motor to the base casting.

7. Replace in reverse order, and make certain that when installed, motor fan blades are not touching wiring cable.

CAUTION

The two motors in the LA30 are *not* interchangeable. The one on the right-hand side is 45 RPM CCW rotating, the other is 15 RPM CW rotating.

5.4.6 Ribbon Drive Clutch Assembly

To check drive clutch assembly, proceed as follows:

1. Check the ribbon tension as shown in Figure 5-8 by slowly pulling ribbon off the reel with the force gauge. Power should be on but clutch not energized. Ribbon tension as it leaves the full spool should be between 2 and 4 oz. If the tension exceeds 6 oz printing may be impaired, and the ribbon may fail to wind or track properly. At 8 oz, the driving clutch may slip and wear excessively. If tension is below 2 oz, the left margin of printing and print quality may be inconsistent.

2. If tension is out of spec and is impairing print quality, remove the snap ring on the motor shaft and remove and replace the clutch and drive spool assembly.

NOTE

The two clutch and drive spool assemblies are not interchangeable, nor are any of their components interchangeable.

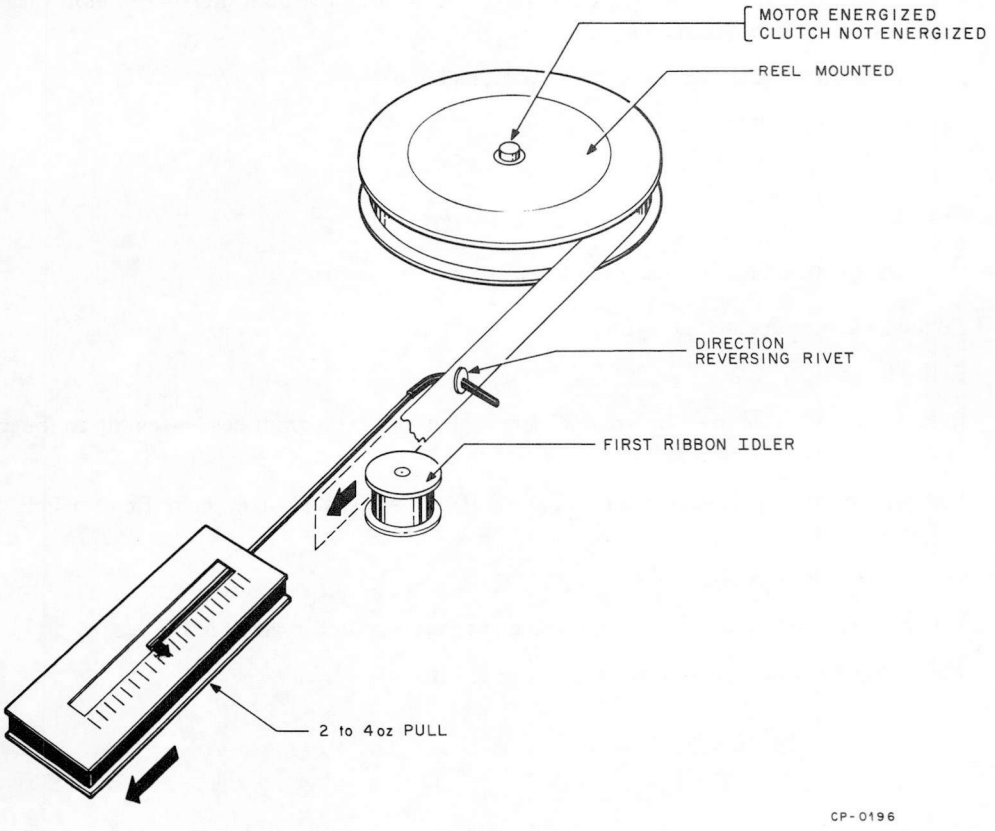


Figure 5-8 Ribbon Tension Check

5.4.7 Carriage Stepping Motor

To remove the carriage stepping motor, proceed as follows:

1. Remove power at CB1.
2. Lift and remove the cover.

NOTE

The cover hinge is secured with spring washers and truarc rings on ends of hinge shaft. When removed, the cover can be sprung off the hinge shaft.

3. Remove the control box cover and swing the logic rack out on its hinges (two captive thumbscrews).
4. Under the base assembly, open the quick-disconnect to the carriage stepping motor.
5. Remove the drive belt (Paragraph 5.4.8, Step 4) from the drive pulley. Loosen the splined setscrew on the drive pulley collar. Remove pulley from motor shaft extension. Loosen splined setscrew on shaft extension collar and on ball bearing collar. Loosen two No. 8-32 screws securing ball bearing to casting. Remove four No. 10-32 screws holding motor. Remove motor, leaving shaft extension in place in machine (Figure 5-9).
6. Place shaft of new motor into shaft extension and slide together until motor face comes squarely against the casting face with the motor leads down. Secure the motor using four 10-32 screws with lock washers. Leave shaft extension collar loose. Secure ball bearing against casting using two 8-32 screws (these screws must be very tight). Push shaft extension into motor shaft as far as possible.
7. Check ball bearing alignment by rotating shaft extension. It should turn freely without binding on motor shaft. If it moves freely, tighten splined setscrews on shaft extension collar and ball bearing collar. Slide drive pulley onto shaft extension and replace drive belt. Reconnect motor leads and set margin as described in Paragraph 5.3.4.
8. When installed, replace logic rack, back cover, and unit cover.
9. Restore power at CB1.

5.4.8 Drive Belt

To replace the carriage drive belt, proceed as follows:

1. Remove main power at CB1.
2. Raise the cover.
3. Remove and set aside the four No. 6-32 screws that secure the print head assembly to the carriage. Carefully set aside the assembly.
4. Push with hand on belt tension arm (Figure 5-10) to release tension on belt. Remove belt from pulleys and carriage.
5. Install new belt in reverse order.
6. Reinstall the print head assembly and realign as described in Paragraph 5.3.2.
7. When installed, lower lid and re-apply power at CB1.

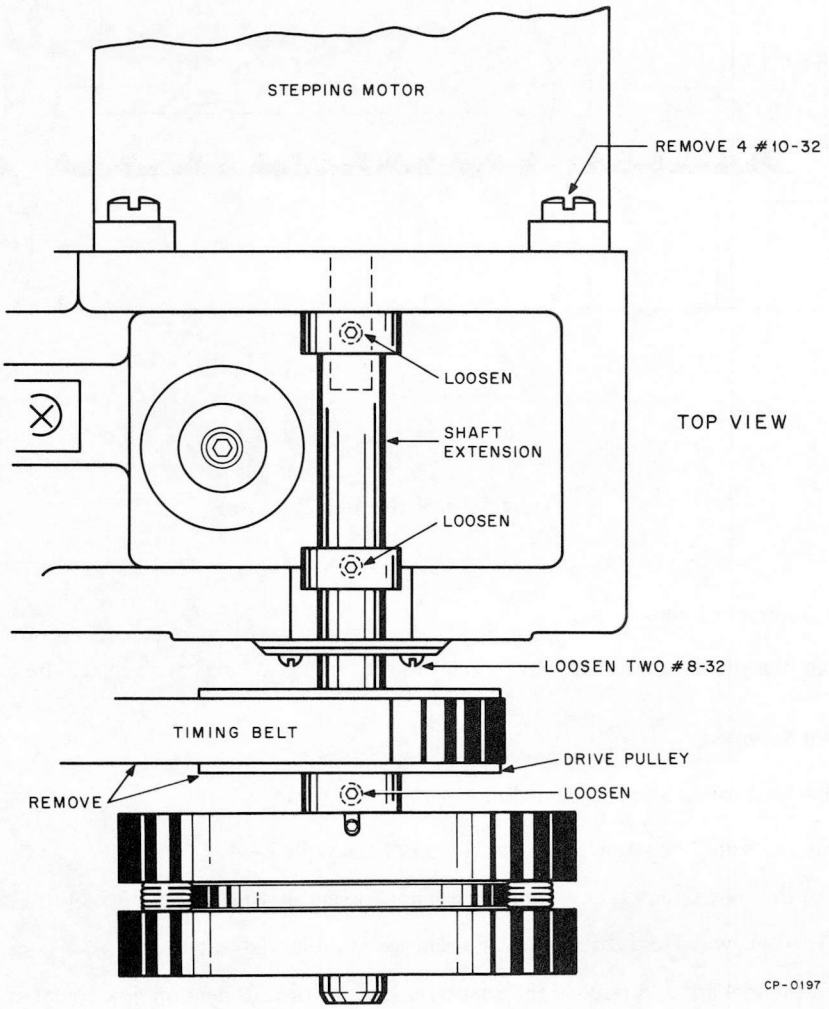


Figure 5-9 Stepping Motor Removal

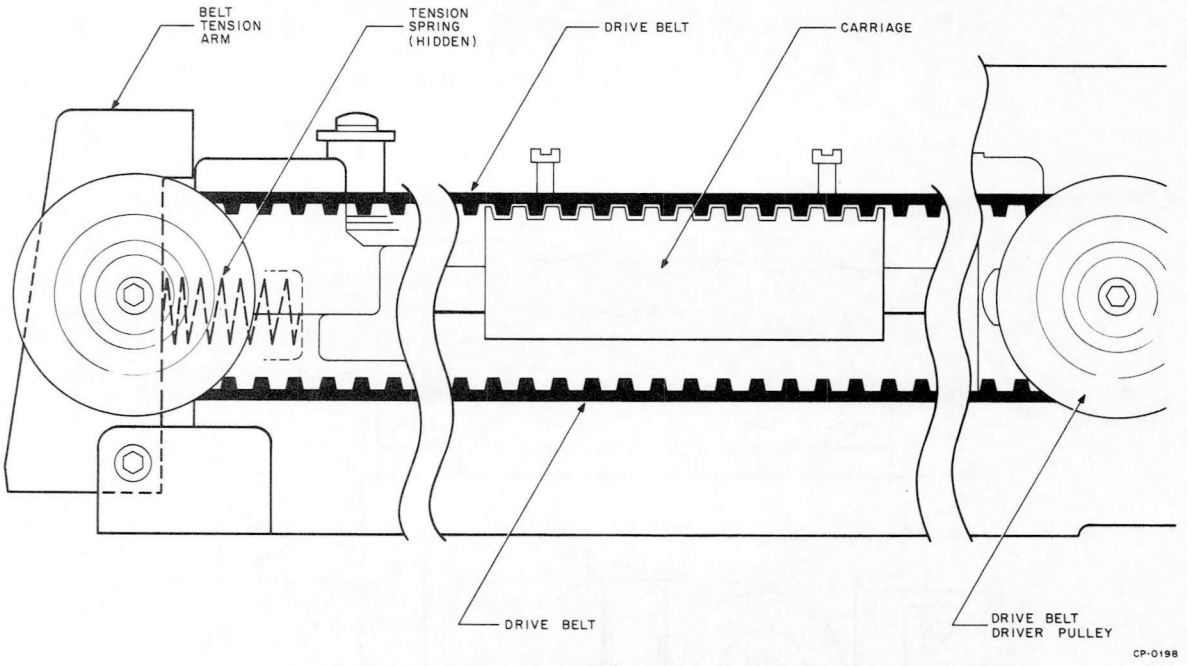


Figure 5-10 Drive Belt Removal

5.4.9 Keyboard Indicator Lamp

If the READY lamp burns out on the keyboard, remove the keyboard bezel and replace the cartridge.

5.4.10 Line Feed Solenoid

To replace the line feed solenoid, proceed as follows:

1. Remove the print bar assembly as described in Paragraph 5.4.4.
2. Remove the four screws that secure the solenoid assembly to the base of the print bar casting.
3. Lift the pawl away from the ratchet and remove the solenoid assembly.
4. Loosen the locknut and remove the adapter and pawl; install them on new solenoid assembly.
5. Replace in reverse order.
6. When installing new assembly, make certain that the solenoid is positioned so that the centerline of the solenoid is vertically in line with the ratchet tooth at the beginning of its stroke (Figure 5-2). The aluminum solenoid mounting plate edge should be recessed 0.062 in. behind the print platen surface. In the opposite dimension, the solenoid should be positioned so that the pawl passes through the detent arm without touching it. Check also to see that all pivot points in the ratchet and pawl mechanism are free and that snap rings are in place.
7. When installed, recheck pawl and detent adjustment described in Paragraph 5.3.1.

CHAPTER 6
INTERFACING

6.1 INTRODUCTION

The LA30 is a parallel, ASCII-coded device. To print a character, the LA30 must have seven data bits and a strobe presented at once. Similarly, when the LA30 keyboard is operated, seven data bits and a strobe are generated simultaneously. The usual interface consists of an 18-pair cable and modules peculiar to the processor type to gate the signals on and off the processor I/O bus. This parallel interface can be used with cable lengths of up to 25 feet and is, in general, program compatible with 10 character-per-second I/O printers.

If a longer cable run is required, or if the LA30 is to be used on a telephone line, a serial interface version of the LA30 must be used.

In the serial versions, additional modules are used in the LA30 to assemble a serial stream of input bits into parallel characters. Similarly, the parallel output of the keyboard is accepted at once and then transmitted one bit at a time. These conversions are controlled by a switch selectable clock, which can operate at 110, 150 or 300 baud. It should be noted that these baud rates must be coordinated at the two ends of the serial signal line, and that some changes must be made to existing software to use the serial LA30 at 300 baud. At 150 or 110 baud, the LA30 can be used interchangeably with low-speed I/O printers. Serial processor interfaces are available for all PDPs. Paragraph 6.2 describes serial interface characteristics; Paragraph 6.3 describes parallel interface characteristics.

6.2 SERIAL INTERFACE

6.2.1 General

The LA30S option is designed to function as a serial interface for the LA30 DECwriter (Figure 6-1). Its purpose is to permit the use of the LA30 as a full-duplex remote terminal. The interface provides facilities for operating the LA30 both on "LINE" and "LOCAL".

6.2.2 Current Loop Operation

The interface contains a level converter module which converts 20 mA current loop data to TTL voltage levels for use by the UART. In the opposite direction, the TTL signals from the keyboard are converted to 20 mA current loop data to the line. Provision is also made in this interface for maintaining an idle "marking" condition on the line, thus preventing erroneous interrupts to the external processor during LA30 power-down periods. In addition, an active buffer can assemble up to sixteen 8-bit characters during carriage return periods.

The option comprises four M-series modules, two rotary switches, and a cable. The four conductor cable (BC05F-15) plugs directly into a cable connector module (M973) in position B18 on the LA30 logic rack. Back wiring between this position and position A18 is made in accordance with the DEC communication interface specification DF11. This has been done to facilitate use of other communication modules on the LA30.

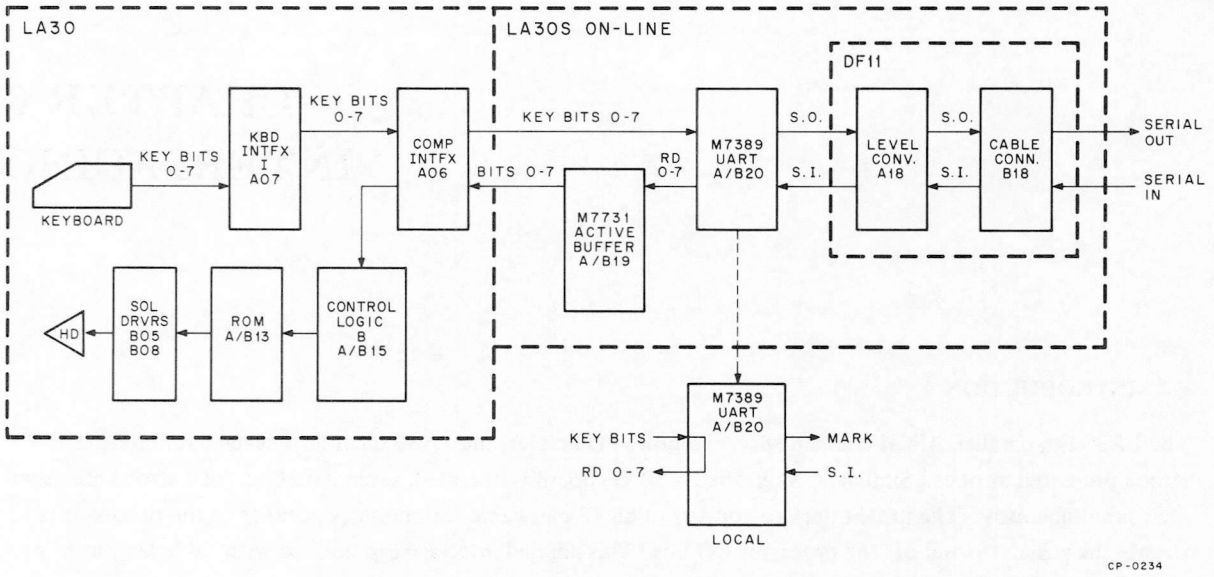


Figure 6-1 LA30S Serial Interface Block Diagram

Position A18 receives an M598 optic-coupled 20 mA to TTL level converter which maintains 1500V isolation from the line while maintaining normal idle line conditions.

An asynchronous transceiver module (M7389) is installed in position A/B20. This module contains a DEC UART MOS chip for parallel/serial conversion, a clock that can be programmed to baud rate, and distribution logic for line/local operation of the LA30.

The option is completed by the installation of an active buffer (M7731) in position A/B19 which functions as both a control on the M7389 transceiver and an accumulator of data during printer carriage return. The option consists of sixteen 8-bit registers for temporary storage of serial input data.

Interconnection is then made, by back-plane wiring, to the LA30 parallel bus on A06. KEY BITS are fed directly to the UART for serialization while PBITS are taken from the active buffer.

The two switches preset control lines to the M7389 module. A mode selector (LINE/LOCAL) provides control levels to the distribution logic. A Baud Rate switch (110-150-300) is wired to supply the M7389 with three 2-bit binary combinations to select the proper clock for 110, 150, or 300 baud operation.

6.2.3 M973 Cable Connector

The BC05F-15 cable is a four conductor cable with male Mate-N-Lok connectors at both ends. It connects between the external computer and the M973 Cable Connector in B18. It is shown in Figure 6-2 in which various configurations of interfacing are shown. This drawing assumes that identical hardware will be used at both ends of the cable.

6.2.4 M598 Level Converter

The M598 module shown on Drawing M598-0-1 consists of two optic-coupled circuits, one for transmission and one for reception. Both circuits are equipped with sets of jumpers which modify the elements associated with the line for either active (source of power or local battery) or passive (not source of power or remote battery)

operation. On the receiver input these connections are designated AR1, 2, 3 for "active" and PR1,2 for "passive" termination. On the transmitter the output connections are prefixed AT and PT.

NOTE
When used with the LA30, the "passive" jumpers (PT1, PT2, PR1, PR2) are always connected.

The actual component in the level converter that provides the current isolation is the opticoupler, designated E1 and E3. The device consists of a Light Emitting Diode (LED) and Photo-Sensitive Transistor. When the diode is energized, the light it emits activates the base of the transistor which, in turn, causes a change in its load loop. This arrangement provides 1.5 kV of isolation input to output, which in remote terminal applications completely isolates the LA30 from the signal line.

Transmission is by negative assertion in which a TTL low (mark) on V2 forces a high output from the NOR gate E2, turning off the LED and the opticoupler. In this condition, Q2 is biased completely on, thereby saturating Q3, which acts then as a current shunt for the 20 mA line.

Conversely, with a TTL high (space) on V2, the opticoupler is turned on, turning off the dc amplifier so that essentially no current flows in the 20 mA loop. In this state, however, 1 mA of leakage current does flow, limited by constant current diode D1.

C2 and C3 are slow-down capacitors to condition the line. They limit the rise time (C2) and fall time (C3) to 10 μs. R2 is a pull-down resistor on the opticoupler to allow faster turn off times.

The receiver half of the M598 is shown on the lower portion of the drawing. Its operation is similar to that of the transmitter. With 20 mA flowing in the line (mark), current flows in the LED turning on the transistor photo coupler, producing a low on D1. In a spacing condition on the line, the coupler is turned off producing a high at D1.

6.2.5 M7389 Addressable Asynchronous Transceiver (UART)

The M598 module feeds the M7389 module in position A/B19. This latter module is shown in Drawing M7389-0-1 and in simplified form in Figure 6-3.

The principal component in this module is a DEC UART chip which functions to convert serial data to parallel form, and parallel characters to a serial bit stream. Input buffers are provided from the keyboard to the UART and output buffers from the UART to the active buffer.

Referring to the drawing, a switchable clock is used to feed receive and transmit multiplexers (E12/E13) which, in turn, supply the UART with R CLK and T CLK for internal timing.

The 844.8 kHz oscillator establishes the basic clocking frequency which is then time-divided to provide the various clocking frequencies required for the different baud rates. In the LA30 only three developed frequencies are used, each being 16 times the baud rate (Table 6-1).

The 1.76 kHz is derived by frequency division counters E1, E2, and E3. The basic 844.8 kHz is applied to two complementing JK flip-flops which feed 211.2 kHz to a divide by 12 chip (E2). The resultant 17.6 kHz is then divided by 10 (E3) to yield 1.76 kHz.

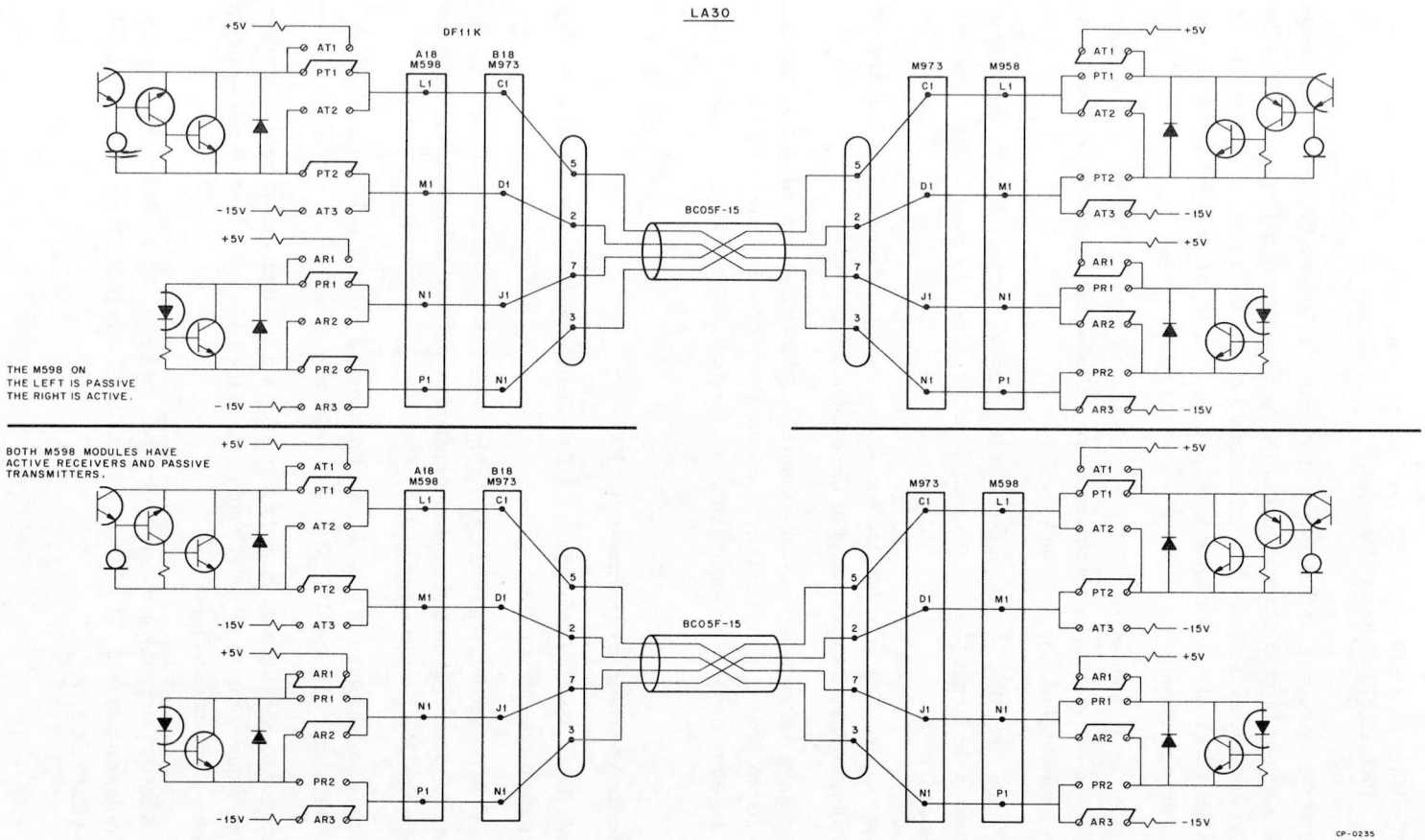


Figure 6-2 Cabling of LA30S to Processor

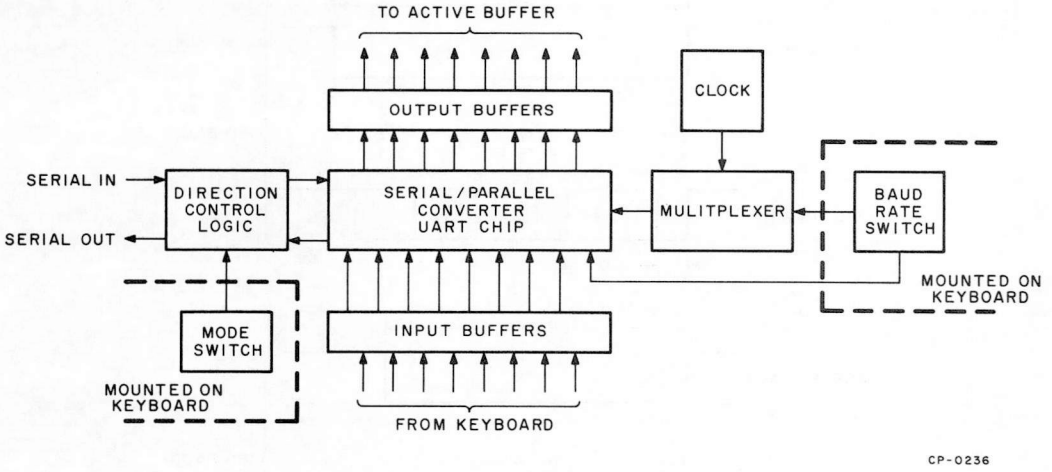


Figure 6-3 M7389 Module Functional Block Diagram

The other two frequencies are produced by E4, E5, and E6. Counter E4 divides the 844.8 kHz by 11 to feed 76.8 kHz to E5, where the frequency is divided by 16 to provide 4.8 kHz for the 300 baud rate. Chip E6 then divides by 2 to yield 2.4 kHz.

NOTE
Other clocking frequencies are available on this module but are not used on the LA30S serial interface.

Clock frequency is selected by the Baud Rate switch, which applies alternate combinations of GND (0) and +3 Vdc (1) to pins A19J2/E2 and A19H2/F2 on the clock multiplexers. These pins correspond to pins 10 and 11 on E12 and E13. Table 6-2 shows the relationship of these binary combinations to baud rate.

Table 6-1
Baud Rate vs Clock Frequency

Baud Rate	Clock Frequency
110	1.76 kHz
150	2.4 kHz
300	4.8 kHz

Table 6-2
Coding vs Baud Rate

Pin 10	Pin 11	Baud Rate
0	0	110
0	1	150
1	0	300

These combinations cause the multiplexers to select one of the three R CLK and T CLK rates at which the LA30 operates. A third level on this switch is sent to pin 36 of the UART (E19) to control the number of stop bits (Figure 6-4). In position 1 (110 baud) it applies +3 Vdc to this pin to cause 2 stop bits to be generated. In positions 2 and 3 (150 and 300 baud) only one stop bit is generated as this pin is grounded.

The mode switch when in LOCAL position, causes serial information from the out terminal to be looped back into the in terminal and printed locally. At the same time it holds the transmit line in a mark condition.

Full-duplex operation is selected when the mode switch is in the LINE position.

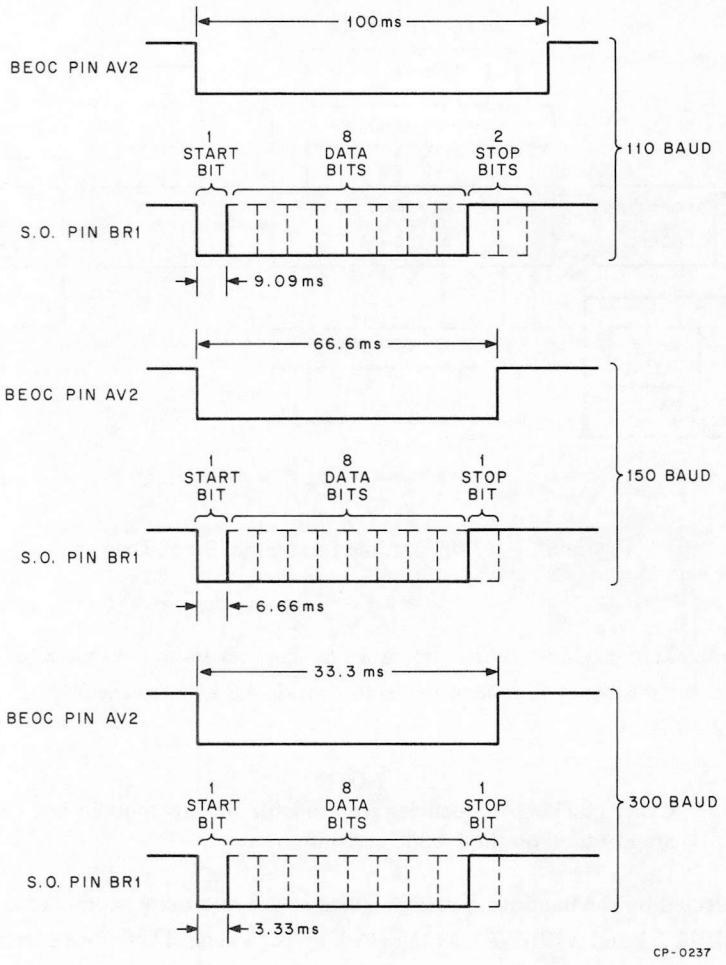


Figure 6-4 LA30S Serialization Formats

A standard LA30S configuration generates the serialized output formats illustrated in Figure 6-4 for the three baud rates. However, the LA30S can be converted to several data formats by proper jumper selection on this module (Table 6-3).

6.2.6 M7731 Serial Interface Control

In either LOCAL or LINE mode, assembled parallel characters from the UART are fed directly to the M7731 module shown in Drawing M7731-0-1. This module is an active buffer comprising eight 4 X 4 matrices (one for each bit in the parallel word being transferred to the printer logic), two 4-bit counters (one for input and one for output control), a 1 μs clock, and six sequencing flip-flops. In addition, comparison logic is set to indicate when the input address equals the output address (MATCH).

This module provides 16 positions into which 8-bit characters from the UART can be stored in rotation as received, and out of which they can be transferred (in the same rotation) to the printer upon demand (PDEM).

NOTE

Normally the "out" register will trail the "in" register by at least one location.

Table 6-3
UART Jumper Selection

Jumper Nomenclature	Function
NP (Machine Inserted)	A jumper inserted here inserts a parity bit immediately after the data bits. Parity is eliminated if no jumper is present.
POE	A jumper placed here inserts and checks odd parity. If no jumper is present, even parity is inserted and checked. Parity selection is conditional on the NP jumper.
NB2, NB1	These two jumpers are coded to select either 5, 6, 7, or 8 data bits/character. Note that the parity bit is not considered a data bit.

Inserted Jumper		
NB2	NB1	Bits/Character
Yes	Yes	5
Yes	No	6
No	Yes	7 (Machine Inserted)
No	No	8

This sequence will continue so long as data is available, and so long as the printer is ready to print. The I register will continue to increment to the next location into which data is to be stored, and the O register will continue to increment to the next location from which data is to be taken. Input rate is independent of output rate and both are dependent only upon timely reception of PDEM and DA. PDEM will normally occur at a 300 baud rate since the LA30 prints at 30 characters/second. DA will occur at whatever baud rate is set in the UART, which could be less than 300 baud. When printing a continuous line, this results in a one-for-one sequence with each input character locating in the next contiguous position in the buffer, and with the buffer appearing to be infinitely long.

At the end of a printed line, however, a carriage return character will initiate that mechanical function in the printer control logic. During the time that the carriage is returning (300 ms) no PDEM is generated and since this signal has no effect on buffer input, the I register will increment 2 or 3 locations ahead of the O register. If the input rate is 110 or 150 baud, when PDEM is again generated it will occur at a 300 baud rate, allowing output to overtake input. In this way the buffer functions to store these lagging characters during carriage return, and then dump them out when printing resumes.

Note, however, that if printing characters are input at 300 baud (top printing speed of the LA30), output equals input during continuous printing periods. Under this condition the printer can never recover after carriage returns and the buffer will fill after several lines of text. This characteristic results in the following Programming Constraint:

CAUTION
When operating in 300 baud, always follow each CR with sufficient (9) fill characters to prevent buffer overrun.

If this constraint is not observed, the buffer will become full and characters will be lost. Non-printing fill characters result in an LA30 cycle time of approximately 2 μs, whereas 33 ms is required for printing characters. It has been calculated that 9 fill characters at 300 baud constitute "worst case" conditions.

6.3 LA30 PARALLEL INTERFACE

6.3.1 General

A parallel LA30 interface consists of an 18-twisted pair cable up to 25 feet long and a set of modules to gate parallel data signals on and off the processor I/O bus. The set of modules is unique to each type of I/O bus.

Controller types currently available:

Controller	Use
LC11	PDP-11 Family
LC8-E	PDP-8/E
LC8-L (used with LA30 as console)	PDP-8/L, PDP-12, PDP-8/I (Pos. Bus), PDP-15 (see Note)

NOTE

I/O printer on PDP-15 does not implement the "hardware echo" feature. Functions normally as an "add-on".

In general, the LA30 parallel interface can be used interchangeably with low-speed I/O printers, having the same commands, codes, etc.

6.3.2 Timing Differences

There are some differences in timing, however, since the parallel LA30 prints at slightly more than 30 characters/second. The differences show up in the time needed to restore the printer flag after a character is sent to the printer.

The LA30 parallel interface works on a "demand–response" basis. When the printer is ready to accept a character, the "demand" line is high-true. When the printer strobe time goes low-true, the character on the printer data lines will be accepted and the demand line goes false until the character is processed. The demand line will stay false for a variable length of time, depending on whether the character is printable or is a function code.

a. Non-Printing Characters – The LA30 examines all characters for printability. If the code received is non-printing, the printer flag is restored within a period of 2 to 6 μs. A problem can occur if the user program sends a non-printing character, such as rubout or null, in order to clear the printer flag and then one or two machine cycles later checks the flag to be sure it went down. The parallel LA30 will have restored the flag by that time, whereas the serial LA30 or other printer would require 30 to 100 ms.

b. Line Feed – The LA30 line feed cycle time is 33 ms or less. When the line feed character is detected, the printer flag will not be restored until the line feed is complete.

c. Carriage Return – When this code is detected, the carriage return cycle starts immediately and is completed in 300 ms or less, during which time no printing occurs. Since there is an internal one character buffer, the parallel LA30 can continue to accept characters until a printing character is received. The printing character will be stored until the carriage return cycle is complete and the LA30 is again ready to print. This feature allows the LA30 to perform line feeds and dispose of "no-op" characters during carriage return time.

d. If the user program neglects the carriage return after printing a full line of characters, a right-hand margin limit switch will operate to inhibit printing. In this mode, the printer demand line is returned within 2 to 6 μs after each character, until a carriage return character is detected.

e. The "local line feed" button on the LA30 front panel is used to advance the paper without sending any character from the keyboard, since this function interferes with printing. The printer demand line is dropped while local line feed is in progress.

APPENDIX A
LA30 ILLUSTRATED PARTS BREAKDOWN

This appendix contains an illustrated parts breakdown (IPB) and associated parts list for the LA30 DECwriter. The parts list is divided into three elements: index number, DEC part number, and the part description.

For illustrative purposes, some repetitive items are shown only once. For example, item 17 (bracket for a cherry switch) is shown in Figure A-1 on the left-hand side of the base; the same bracket is also mounted on the right-hand side of the base but is not shown. The reader is advised to bear this in mind when assembling a unit or ordering a part.

The following table lists spare parts that each LA30 customer should have as recommended by DEC Field Service. The index numbers used in Figure A-1 through A-5 are provided in the customer spare parts list to aid in parts identification.

LA30 Customer Recommended Spare Parts List

Description	DEC Part No.	Qty*	Index No.**
Belt, drive	12-10341	1	92
Clutch coupling assembly, left-hand	74-09216-2	1	23
Clutch coupling assembly, right-hand	74-09216-1	1	24
Diode bridge	11-05397	1	146
Lamp, indicator	12-02116-1	1	135
Motor, ribbon drive (clockwise)	12-10316-4	1	10
Motor, ribbon drive (counterclockwise)	12-10316-3	1	11
Print head assembly	70-07273	1	129
Spool, ribbon, full	36-10558	1	21
Spool, ribbon, empty	36-10966	1	22
Sprocket, paper drive	12-10435	1	55
Switch, cherry	12-10340	2	64
Switch, end-of-ribbon	12-10339	1	14

* Indicates recommended quantity per LA30 unit.

** These numbers refer to Figures A-1 through A-5 of this appendix.

LA30 Parts List – Figure A-1

Index No.	DEC Part No.	Description
1	12-10434	Cover
2	90-06010-3	Screw, Phillips truss head #10-32 X 5/16
3	90-07651	Washer, external tooth #10
4	74-08689	Hinge, cover
5	90-08500	Ring, retaining
6	90-09219	Washer, spring
7	74-08641	Base (mach)
8	74-09658	Bumper, cover
9	90-06035-1	Screw, Phillips pan head #8-32 X 1/4
10	12-10316-4	Motor, ribbon drive (clockwise)
11	12-10316-3	Motor, ribbon drive (counterclockwise)
12	90-06015-1	Screw, Phillips pan head #4-40 X 3/4 SST
13	90-06557	Nut, Keps #4-40
14	12-10339	Switch, end-of-ribbon
15	90-06022-1	Screw, Phillips pan head #6-32 X 3/8 SST
16	90-06633	Washer, internal tooth #6
17	74-08675	Bracket, ribbon switch
18	74-09003-2	Pivot plate assembly, left-hand
19	74-09003-1	Pivot plate assembly, right-hand
20	90-08899	Ring, retaining
21	36-10558	Spool, ribbon, full
22	36-10966	Spool, ribbon, empty
23	74-09216-2	Clutch coupling assembly, left-hand
24	74-09216-1	Clutch coupling assembly, right-hand
25	74-09052	Shield, module board
26	90-07622	Grommet, caterpillar
27	90-06013-1	Screw, Phillips pan head #4-40 X 1/2 SST
28	90-06632	Washer, internal tooth #4
29	G381	Board, module (G381)
30	90-08308	Spacer, 1/4 AF X 11/64 LG
31	90-06340-8	Screw, socket head #8-32 X 3/4
32	74-09213	Idler pulley, ribbon
33	90-06660	Washer, flat #8
34	90-06022-2	Screw, Phillips flat head #6-32 X 3/8 SST
35	74-09542	Bezel, keyboard, parallel
36	74-09541	Bezel, keyboard, serial
37	12-10360-3	Screw, shoulder 1/4 X 1-1/4
38	90-09227	Spacer
39	12-10357-3	Bushing, rubber mount
40	74-08677	Support bar
41	90-06300-10	Screw, socket set #8-32 X 3/16
42	12-10358-3	Ring, rubber mount
43	74-08680	Print bar (mach)
44	90-08045-8	Screw, socket head cap #6-32 X 3/8

LA30 Parts List – Figure A-1 (Cont)

Index No.	DEC Part No.	Description
45	90-07801	Washer, split lock #6
46	90-06653	Washer, flat #6
47	74-08662	Cam, lever
48	74-08663	Cam
49	90-08502	Washer, spring
50	74-08664	Shaft, cam
51	12-10359	Bushing, flanged
52	90-06076-1	Screw, Phillips pan head #10-32 X 7/8 SST
53	90-07906	Washer, internal tooth #10
54	74-09666	Wedge
55	12-10435	Sprocket, paper drive
56	12-10356	Bearing, ball
57	74-08672	Shaft, spline
58	12-10474	Spring, paper tension
59	74-08671	Knob, paper tension
60	90-06353-8	Screw, socket head cap #10-32 X 1-3/4
61	90-06005-1	Screw, Phillips pan head #2-56 X 1/2 SST
62	90-06686	Washer, split lock #2
63	90-08877	Washer, flat #2
64	12-10340	Switch, cherry
65	74-08660	Block, switch
66	90-06011-2	Screw, flat head mach. #4-40 X 3/8 SST
67	90-06563	Nut, Keps #8-32 SST
68	74-08666	Bolt, spring
69	74-08648	Spring, paper drag
70	12-10344	Bushing, ball
71	90-06024-1	Screw, pan head #6-32 X 1/2
72	12-11026	Mounting plate, solenoid
73	12-10473	Spring, solenoid
74	12-10495	Bumper No. 1
75	90-09225	Washer, Mylar
76	90-09061	Nut, stop
77	12-10496	Bumper No. 2
78	12-10342	Solenoid assembly
79	74-08646	Nut, check
80	74-08665-2	Pin, roller
81	74-08678	Adapter, pawl
82	74-08696	Pawl assembly
83	90-08501	Ring, retaining
84	74-09799	Detent
85	12-11061	Spring, pawl engagement
86	90-09231	Spring, detent
87	74-08657	Support carriage
88	12-10360-2	Screw, shoulder 1/4 X 5/8

LA30 Parts List – Figure A-1 (Cont)

Index No.	DEC Part No.	Description
89	90-07797	Washer, split lock 1/4
90	90-06646	Washer, flat 1/4
91	74-08884	Pulley, idler
92	12-10341	Belt, drive
93	74-08647	Tension arm, belt
94	12-10353	Spring, belt tension
95	12-10352	Spring, belt tension
96	90-06346-8	Screw, socket head cap #10-32 X 1/2 SST
97	90-07906	Washer, split lock #10
98	90-06664	Washer, flat #10
99	74-08928-2	Spring assembly, left-hand
100	74-08928-1	Spring assembly, right-hand
101	74-09665	Bracket, switch interlocking
102	90-06025-1	Screw, Phillips pan head #6-32 X 5/8 SST
103	12-10432-2	Hold-down paper, left-hand
104	12-10432-1	Hold-down paper, right-hand
105	12-10360-1	Screw, shoulder 3/16 X 3/4
106	74-08655	Idler, pulley ribbon
107	90-09226	Washer
108	90-09979	Washer, flat
109	74-08652	Ways, backstop
110	90-06347-8	Screw, socket head cap #10-32 X 5/8 SST
111	12-09369	Motor, stepping
112	90-06036-1	Screw, Phillips pan head #8-32 X 5/16 SST
113	90-06690	Washer, split lock #8
114	74-08654	Clamp, shaft
115	74-08653	Shaft, square
116	74-08903	Collar
117	74-08644	Shaft, extension
118	90-06338-3	Screw, Phillips truss head #8-32 X 1/2 SST
119	12-10355	Bushing, flanged
120	74-08645	Pulley, driver
121	12-11055	Main drive disk
122	12-11058	Bushing
123	12-11056	Friction disk, drive (triangular)
124	12-11057	Friction disk, driven (circular)
125	74-09829	Adapter, drive shaft
126	12-11059	Spring, extension
127	90-08132	Pin, dowel
128	90-07794-1	Screw, Phillips pan head #6-32 X 11/16 SST
129	70-07273	Print head assembly
130	74-08933	Carriage assembly
131	74-08656	Shaft, round
132	74-09222	Clamp, shaft

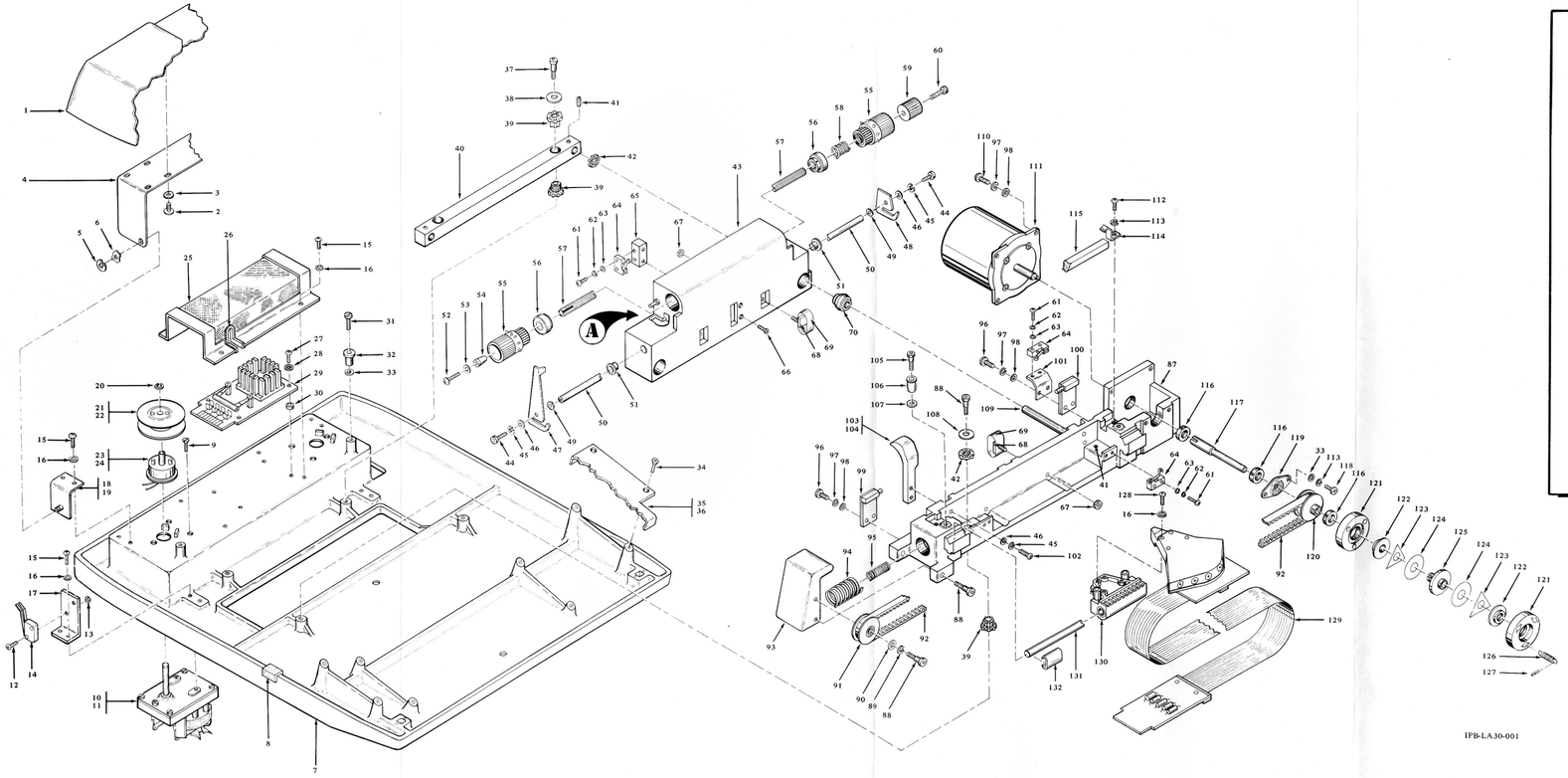


Figure A-1

LA30 Parts List – Figures A-2 and A-3 (Cont)

Index No.	DEC Part No.	Description
15	90-06022-1	Screw, Phillips pan head #6-32 X 3/8 SST
16	90-06633	Washer, internal tooth #6
28	90-06632	Washer, internal tooth #4
133	54-09914-1	Board, control assembly–parallel
134	54-09914-2	Board, control assembly–serial
135	12-02116-1	Lamp, indicator
136	90-07129	Clip, speed
137	90-08301-1	Screw, Phillips pan head #4-40 X 1/4
138*	90-08487	Retainer, ball stud
139	54-09945	Keyboard assembly
140	90-06011-1	Screw, Phillips pan head #4-40 X 3/8 SST
141	74-09673	Bracket, bell
142	12-10981	Bell, warning
143	70-08342	Unit harness
144	70-07281	Cable, keyboard
145	12-02704	Clamp, cable

* The ball stud retainer (DEC no. 90-08487), shown in Figure A-3, is used on earlier versions of the LA30. Later LA30 units employ a cover clip which is not shown in this IPB. The part number for this new cover clip is 12-11107.

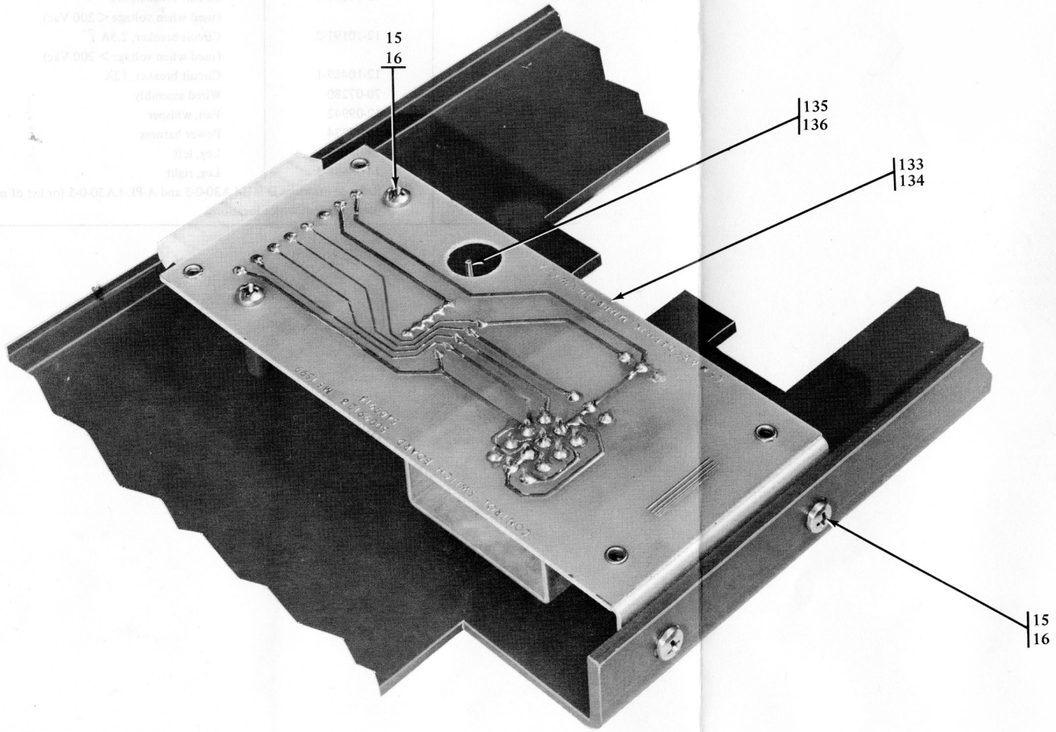


Figure A-2

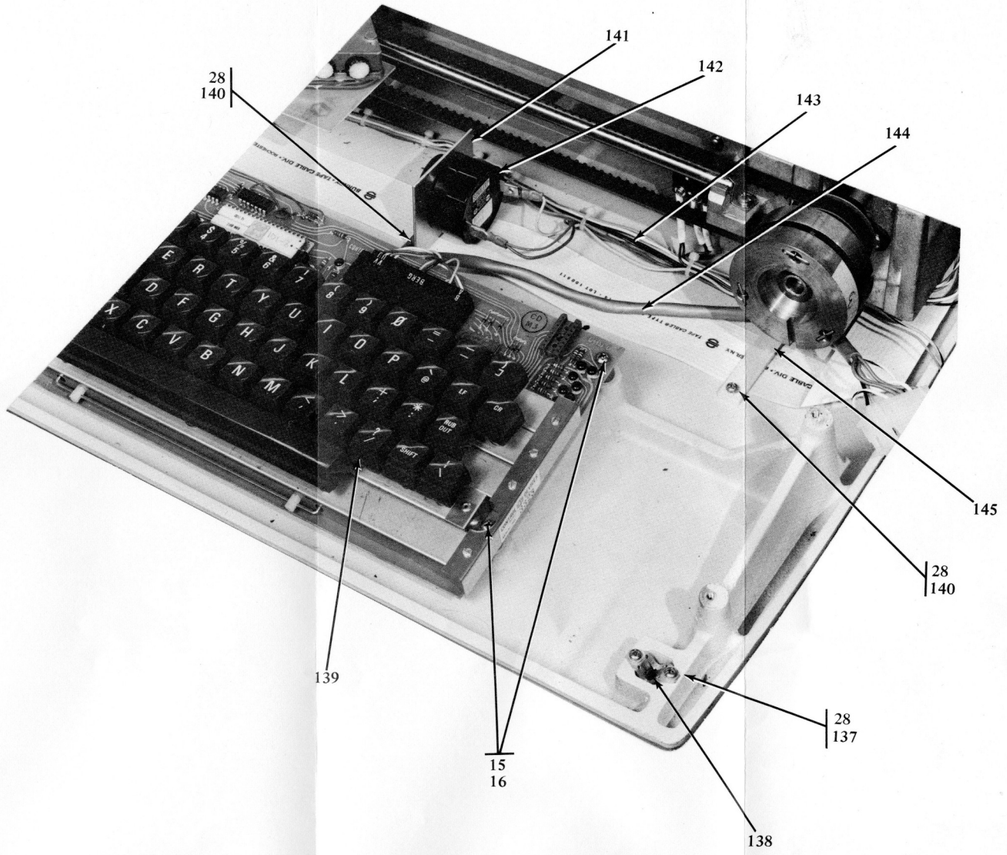


Figure A-3

LA30 Parts List – Figures A-4 and A-5 (Cont)

Index No.	DEC Part No.	Description
146	11-05397	Diode bridge
147	12-10191-1	Circuit breaker, 5A (used when voltage < 200 Vac)
148	12-10191-2	Circuit breaker, 2.5A (used when voltage > 200 Vac)
149	12-10489-1	Circuit breaker, 12A
150	70-07280	Wired assembly
151	12-09942	Fan, whisper
152	70-07274	Power harness
153	74-08658-1	Leg, left
154	74-08658-2	Leg, right
155	Refer to drawings D-MU-LA30-0-5 and A-PL-LA30-0-5 for list of modules and module slot locations.	

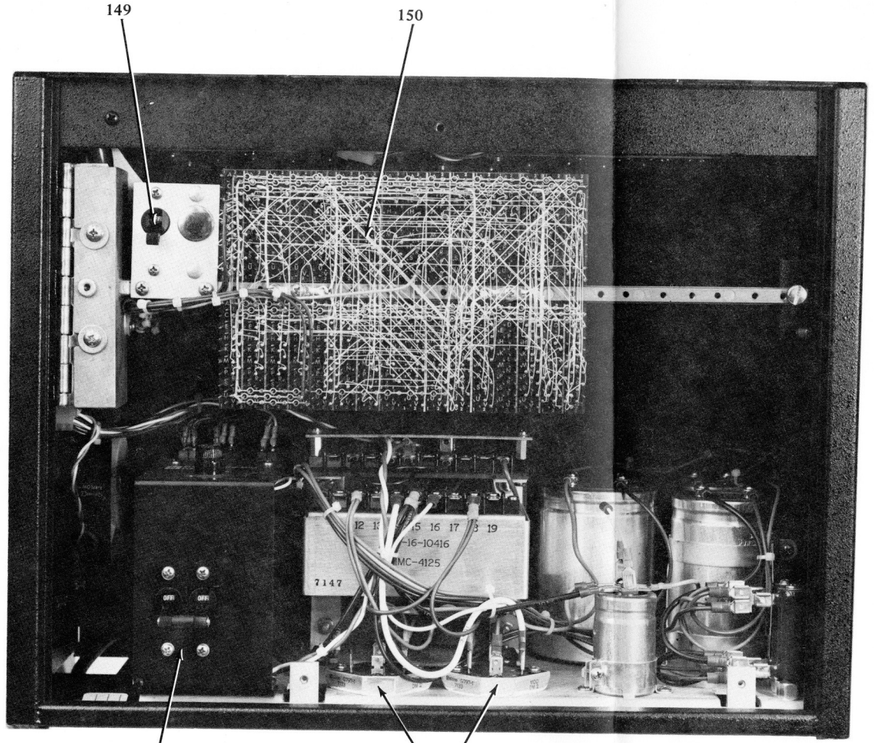


Figure A-4

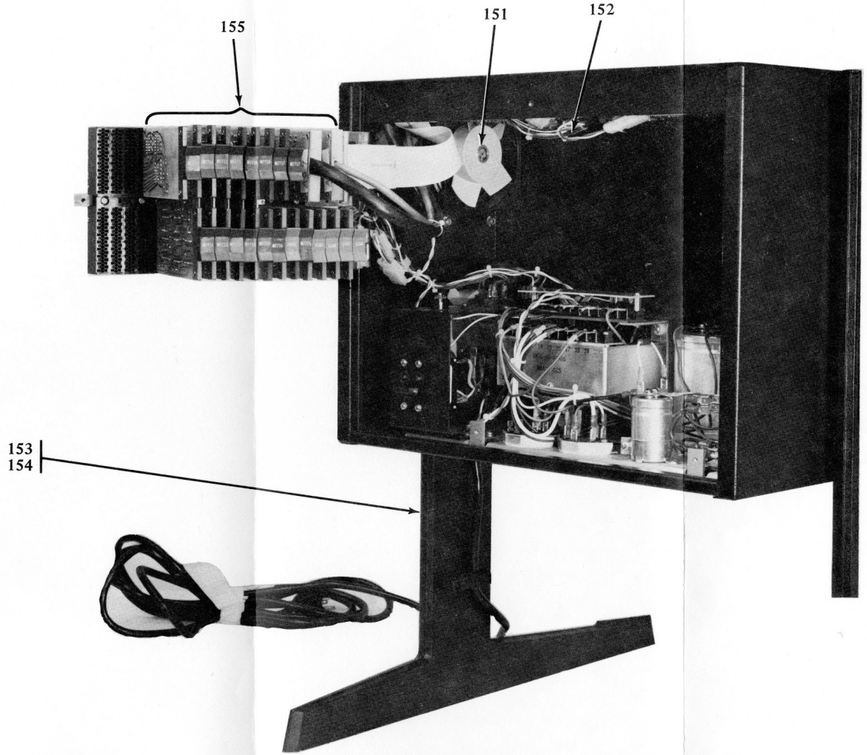


Figure A-5

READER'S COMMENTS

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DEC-00-LA30-DC

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